- What advantage + disadvantage of zinc
- What deoxidize gold or brass dentures
- What is silex, how made use of
- What is vehicle in shellac varnish?
  sandarac varnish
- When do you scrape impression when indicated? model? why?
- define solarige, vulcanize, flux.

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GEO. W. WARREN, A.M., D.D.S.

PROFESSOR OF CLINICAL DENTISTRY, PENNSYLVANIA COLLEGE OF DENTAL SURGERY, PHILADELPHIA; AUTHOR OF "A COMPEND OF DENTAL PATHOLOGY AND DENTAL MEDICINE;" EDITOR OF "RICHARDSON'S MECHANICAL DENTISTRY"

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PHILADELPHIA

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PREFATORY NOTE.

The demand for a new edition of this work has encouraged the author, while revising the text in accordance with present day technic, to increase its size sufficiently to incorporate new material demanded by existing methods of teaching, and to broaden its scope without materially altering its form which, as evidenced by its sale, has proved so generally acceptable.

In its preparation, care has been taken to make it a sound and conservative guide for the student in his study of the subjects considered. Obsolete methods have been eliminated, and the multiplication of theories avoided, that the dimensions of the work should be kept within convenient limits. The needs of the student having thus been kept in mind, it is presented as a convenient, every day working book.

The author acknowledges his indebtedness to Professor J. Bird Moyer for valuable suggestions in the preparation of the section on Metallurgy; also to Professor E. H. Angle for the free use of illustrations from his work on Malocclusion of the Teeth.

JANUARY 1, 1905.

CONTENTS.

PAGE.

INTRODUCTION, ... 1
Examination of the Mouth, ... 2
Materials Employed in Obtaining Impressions of the Mouth, ... 5
Methods of Taking Impressions of the Mouth, . . 8
Plaster Models or Casts, ... 16
Manner of Taking the "Bite," 20
The Selection and Arrangement of the Teeth, . . 27
Flasking, Vulcanizing, and Finishing the Rubber Base, . 43
Celluloid as a Dental Base, ... 62
Artificial Dentures Constructed by the Swaging Process, 76
Artificial Dentures upon a Cast Metal Base, . . . 100
Artificial Dentures upon an Electro-deposited Base, . 102
Deposition of Copper, ... 102
Deposition of Silver, ... 104
Deposition of Gold, ... 107
Artificial Dentures Formed by the Continuous-Gum Process, ... 109
Metallic Base with Rubber or Celluloid Attachment, . 115
Obturators and Artificial Velum, ... 118
Interdental Splints, ... 127
Appliances for the Correction of Dental Irregularities, . 133
Crown- and Bridge-Work, ... 159
Bridge Dentures, ... 184

DENTAL METALLURGY, ... 195
Gold, General Properties, etc., ... 201
Preparing Alloys of Gold for Dental Purposes, . 202
Refining Gold, ... 215
Platinum, ... 223
Silver, ... 225

PAGE.

Aluminum, ... 229
Zinc, ... 232
Lead, ... 233
Tin, ... 234
Copper, ... 235
Iron, ... 237
Antimony, ... 240
Bismuth, ... 241
Mercury, ... 242
Amalgams, ... 244
Alloys, their Treatment and Behavior in the Process of Compounding, ... 249
Solders and Soldering, ... 254
INDEX, ... 259

MECHANICAL DENTISTRY

AND

METALLURGY.

INTRODUCTION.

The thoroughly qualified dentist is to some extent physician, surgeon, artist, and mechanic. In these pages the operative and medical aspects of dental practice are not considered, but rather the principles, methods and materials which assist in developing the mechanic and the artisan, coupled with the artist. In our study of dental prosthesis we must recognize at once, that the fundamental principles of mechanics are based upon established laws—they are scientific, that is, they agree with or depend upon the rules or principles of science. Also that dental mechanics embodies unusual art possibilities, and that the esthetic requirements are met in accordance with the artistic conception and culture of the dentist.

Before taking up the process and methods appertaining to this department of dental practice, some general reflections may be advantageous to the student. Dr. Richardson, in his Treatise on Mechanical Dentistry, says: "The untimely or premature loss of the natural teeth may be ascribed to a number of diverse causes. Multitudes are lost in consequence of abuse or neglect, or the dread of pain so commonly associated with the means employed in their preservation; many from unavoidable accident; and count-

less numbers are sacrificed through the incompetency and dishonesty of ignorant and unscrupulous persons, who, in one guise or another, infest and prey upon communities."

Though the intelligent practitioner finds it necessary to extract many teeth, it is in a large majority of cases due to negligence on the part of the patients or their parents, the teeth having been permitted to remain in a diseased condition until such procedure is necessary; it is fair to assume too, that the time will never come when thousands of teeth will not be sacrificed. We cannot transgress Nature's laws without paying the penalty. This field, then, will ever be a growing one, not in the number of artificial dentures required, perhaps, but in fulfilment of the possibilities of the prosthetic and esthetic in art.

While it is the distinctive office of prosthetic dentistry to devise and perfect means and appliances for correcting the deformities caused by the loss of the natural teeth, the first step in all cases is to make a careful and thorough examination of the mouth; more intelligent advice may then be given as to the form and class of denture to be inserted.

EXAMINATION OF THE MOUTH.

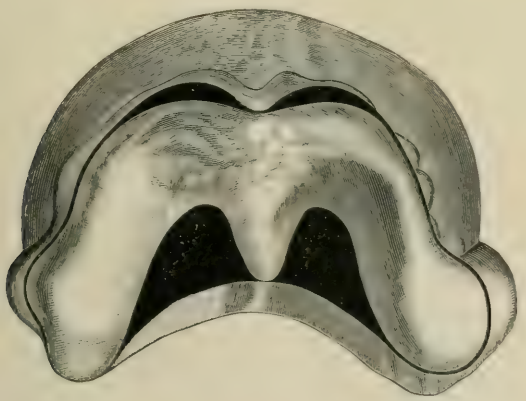
In examining the mouth the following conditions should be considered: first, where only a few teeth are lost, whether a removable denture in the form of a plate, or a removable or immovable bridge should be advised; and where all the teeth are lost, or where an impression is required for a plate of any kind, we should consider the shape of the jaws, whether long or short, deep or shallow, hard or soft; whether the alveolar ridge is firm or in a soft and flexible condition; whether the relative position of the jaws are correct, or the upper or lower protrude; and then if there are any remaining teeth, whether or not they can be made

useful or whether they would interfere with the comfort, usefulness and artistic appearance of the artificial denture.

To illustrate, and impress upon the student's mind the importance of a careful study of each individual case and its peculiarities, we call attention especially to two or three deformities.

The first is that of a gentleman brought under our notice for advice as to whether an artificial denture could be constructed so that it could be used for mastication. The accompanying illustration (Fig. 1) shows the condition

Fig. 1.

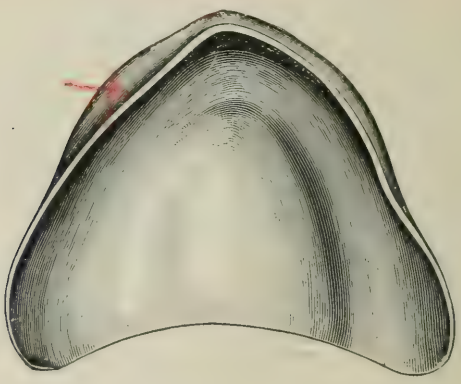


of his upper jaw. The alveolar ridge in the anterior part of the mouth was completely absorbed, while the posterior portion in the region of the tuberosities was very much hypertrophied. He reported that within three years he had had plates constructed by as many different dentists, but without receiving any permanent satisfaction. A denture was made for him which has now been worn for several years with much comfort and usefulness. Success in this case lies (1) in securing an accurate cast; (2) in the location of the plate line and in carving the cast suffi-

ciently at the soft points, and (3) in securing a correct articulation. The plate line in this case, and the extent of the carving is shown in the shaded portions of the illustration. We might mention that the relative position of the jaws in this case was not normal there being a tendency to a slight protrusion of the lower teeth. In the three plates previously made, the normal articulation had been adhered to, and as stated without success.

One of the most frequent deformities is the lack of symmetry in the alveolar ridge. For instance, in a large percentage of cases, it will be found that there is a greater depression upon the left side of the mouth than upon the

FIG. 2.



right. Fig. 2 shows a base-plate which has been formed over such a model. Dr. Eugene Talbot reports that out of 298 examinations of models he found 268 with marked depressions upon the left side, and 24 with the depression upon the right side, and only 6 cases showing both sides to be alike.

This depression is not so apparent upon a casual glance, for it is not so much in the alveolar process as in the maxillary bones. Dr. Haskell says of this, that a plate

swaged upon a model from an impression taken high over the region of the cuspids (as should always be done) shows at once the depression of the left side, which occurs, to a greater or less extent, in 95 per cent. of cases. The difference becomes apparent in arranging artificial teeth. Every dentist of experience must have observed that greater length of teeth and gums is required upon the left side than upon the right. How often it is seen that the left side of the lip rises higher in talking and laughing, than the right side. The difference in the two sides of the lower jaw does not occur as often, but is apparent in the divergence of the left side from a line drawn through the center of the model, so that the posterior teeth on that side must be set farther in upon the plate.

For the purpose of restoring the contour of the face this deformity, when present, should be recognized and studied especially by those engaged in arranging artificial teeth and waxing up plates. These peculiarities are cited simply as two or three instances of the many which may arise in dental practice, calling for good judgment upon the part of the dentist, in deciding upon the best course to pursue. Not only should the plaster models be studied but the mouth should be carefully and critically examined before taking the impression.

MATERIALS EMPLOYED IN OBTAINING IMPRESSIONS OF THE MOUTH.

Plaster-of-Paris.—Plaster-of-Paris, technically, calcium sulphate ($CaSO_4$), has been employed for many years for taking impressions of the mouth, and is in nearly all cases the very best material known for that purpose. Plaster-of-Paris occurs in nature, as a mineral called gypsum. This differs, however, from the dried calcium sulphate of com-

merce (sulphate of lime or plaster-of-Paris) in that it contains two molecules of water of crystallization ($CaSO_4$, $2H_2O$). The water of crystallization is driven off at 392° F., leaving a white, opaque mass, which is then known as plaster-of-Paris. This, however, readily recombines with water, forming a hard mass. The setting process is regarded as a chemical action, the water being taken up in proportion of two molecules to one of the plaster. The result being chemically the same as it is in its native state, $CaSO_4,2H_2O$.

Professor Henry Leffmann says: "The facility with which this combination occurs depends largely on the care which has been taken in preparing the plaster. If it has been too highly heated, the power of taking up water is lost. The presence of impurities also, of course, interferes with the setting qualities. It is well known that the many saline substances, *e. g.*, common salt, hasten the setting, but the exact cause of this is not definitely known. In the case of common salt a double composition occurs to a slight extent, by which calcium chlorid and sodium sulphate are formed. When a solution of the so-called liquid silex, which is sodium silicate, is put on a plaster cast, a similar reaction often occurs, forming sodium sulphate and calcium silicate, and the sodium sulphate appears on the surface of the cast in white, moss-like tufts."

Plaster-of-Paris has taken its name from its abounding at Mont-Martre, near Paris, this being the most important deposit known.

Modeling Composition.—Modeling composition or compound is composed of gum dammar, stearin, and French chalk, with carmin as a coloring-material, and a little perfume to render it more pleasant. There are several varieties manufactured; the degree of hardness of each is due to the quantity of stearin and chalk incorporated with the gum.

This material has of late years largely superseded the use of beeswax for impressions, on account of its taking a somewhat sharper impression and being more elastic. It has also many more desirable properties than gutta-percha, which was formerly used extensively, but is now employed to such a limited extent that it will not be considered in this work.

The slightly elastic properties of modeling composition makes it more suitable for impressions where there are any overhanging ridges, bell-shaped teeth, or dove-tailed interdental spaces.

Both modeling composition and beeswax may be prepared for use by softening with either dry heat or immersing in hot water. Before removing an impression in either of these materials from the mouth, it should be cooled somewhat to preserve the form unchanged.

Beeswax.—Beeswax is a solid, concrete animal product, prepared by the honey bees, and is extracted from the comb after the honey has been removed. There are two varieties of this wax in common use, the white and yellow. When first obtained from the comb it is of a bright yellow color, and in order to bleach it and obtain what is known as white wax it is reduced to thin cakes exposed for a long time to the sun in the open air; this renders it less tenacious, but it is preferred by some on account of its color.

Moldine.—Moldine is a plastic material devised particularly to secure the impression of a single tooth, either in or out of the mouth, for the purpose of securing a metal die of the same. It is composed of potter's clay mixed with glycerin to the consistency of stiff putty. With this material the operator is enabled to quickly secure a metallic die of a tooth directly from the impression.

METHODS OF TAKING IMPRESSIONS OF THE MOUTH.

Impressions in Plaster.—Before mixing the plaster a suitable impression tray or cup should be selected. In determining this the cup should be tried in the mouth, and if exactly adapted to the case proceed as follows:—

For full upper impressions place a piece of softened beeswax across the rear of the palatine portion of the cup (Fig. 3 shows the form of cup to be used with a layer of wax in position) just sufficient to support the plaster at that point, making it more certain to secure a correct impression of the palate; especially is this necessary where the arch is high. It also aids in keeping the plaster from being forced over the rear of the cup into the fauces. If the tuberosities are deep a little wax should be placed around the posterior corners of the cup, and when the alveolar ridge is unusually deep, and it is desirable to obtain a high impression over the region of the cuspids, place a layer of wax over the edge of the cup at these points also, before mixing the plaster.

Method of Mixing Plaster.—The best method is that which most perfectly excludes the air, prevents expansion, and gives the sharpest and smoothest impression.

1. A medium-sized bowl (rubber is the most convenient) should be partially filled with water (warm water is pleasanter for the patient and hastens the setting of the plaster); to this should be added about ten grains of common salt, to hasten the setting and to make the plaster more brittle. It is better to add the salt at this time, that is, *before* adding the plaster, as it gives it a better opportunity to become uniformly diffused. Other agents, such as chlorate of potash, potassium sulphate, and alum, have been and are used to hasten the setting of plaster, but salt is the least objectionable and answers every purpose.

2. The plaster should then be *sprinkled* into the water by tapping the spatula on the edge of the bowl; this will allow the air which is always found in plaster to escape before the plaster sinks. This sprinkling process should be continued until all the water is taken up; or when a sufficient quantity for the case in hand has been added, pour off the surplus water, then add what plaster can be

FIG. 3.

conveniently carried on the spatula. This will usually give the proper consistency for taking impressions, that is, just thick enough not to run off an inverted impression cup or the spatula.

3. The mixture should then be quickly and thoroughly stirred for about ten seconds, so that every particle of plaster has an opportunity to absorb the proper amount of water.

Full Upper Impression, Position of Patient, etc.—After the plaster has been prepared and mixed as directed, fill the tray about level full, not more unless the palate or arch is unusually high, in which case place a little more over the wax at this point. Stand at the right side of the chair, and direct the patient to *sit erect;* then pass the left hand around the patient's head and with the index finger distend the lips. Bring the right heel of the tray into the mouth, then allow the side at about the cuspid angle to press slightly against the right side of the mouth, when the left heel may be readily passed over the finger. Now take sufficient time to place the cups in proper position, carefully pressing the rear in place, *afterward* bring it up firmly in front. This will force any excess of plaster forward. Now, by having the first two fingers of each hand support the cup under the center of the alveolar ridge, the pressure will be equally distributed, and the thumbs will be free to press the lip in and up, so as to force the plaster well up over the alveolar ridge.

If there is retching (tendency to vomit), incline the patient's head a little further forward and direct him to *resist* the tendency, to keep the tongue and throat quiet, and breathe entirely through the nose, which act keeps the mouth and throat quiet, and therefore less liable to irritation from the impression material and accumulation of saliva in the mouth.

If the line of wax has been placed across the heel of the impression cup, and the directions carried out, further treatment need seldom be resorted to. There are rare instances, however,—some cases of cleft palate, for example,—where the soft palate is so extremely sensitive that it will not permit sufficient contact without some local or constitutional treatment.*

* As a constitutional remedy, bromid of potassium is probably the

Tests for Perfect Impression.—The most reliable test for a perfect impression is the degree of resistance to its removal. The time for removal can be ascertained by breaking a small piece of the plaster from the surplus in front; as soon as there is a clean, sharp break the impression should be promptly removed. If left in beyond this time the moisture may be extracted from the mucous membrane causing greater adhesion and possibly rupturing that delicate surface.

Manner of Removing Impression.—The resistance which results from the exclusion of the air from between the plaster and the mucous membrane of the palate should be considered where a perfect impression has been secured. This is best overcome by raising the lip and cheek on the sides and in front, allowing the air to pass in over the rim of the tray; which will usually allow it to be readily removed. Should there be further difficulty, however, the air may be admitted by pressing up the soft palate at the rear of the tray; or the patient may be directed to give a slight cough; this will raise the soft palate and admit the air between it and the impression, allowing it to be easily taken out.

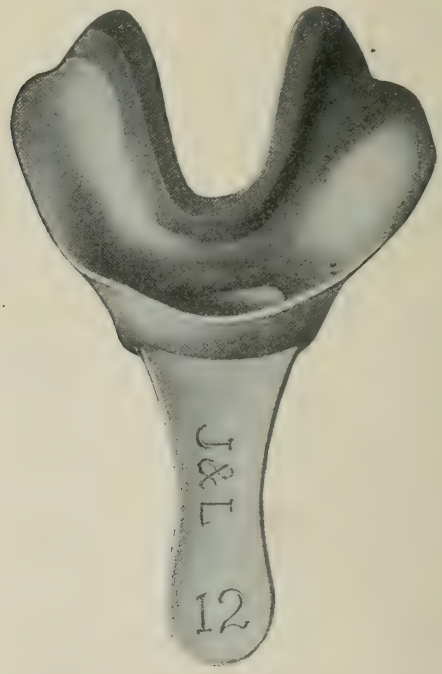
Full Lower Impression.—A tray of suitable shape (see Fig. 4) and size should be selected, and modified with a rim of wax to suit the case in hand; it is also advisable, especially where a new or very smooth tray is to be used, and where the mouth presents a decided undercut, to place a film of wax over its surface to prevent the plaster leaving it.

Fill the tray with plaster, prepared as before, then step to the right side and a little in front of the chair, facing the patient, so that you may more readily see to place the

best; give 10 grains before retiring, 20 grains the following morning, and 20 grains additional in a few hours; one hour after which take impression. Local treatment consists in making application of cocain or manipulating the parts with a feather or edge of a napkin, or in gargling the throat with camphor water just before taking impression.

tray in the proper position. Distend one corner of the mouth and the cheek with the side of the impression tray as it is being passed into the mouth, and the other at the same time with the left hand, and adjust the cup to the ridge, that is, place it so that the center of the cup will come directly over the top of the ridge.

Fig. 4.



Now step back quickly to the position taken for upper impressions, pass the left hand back of and around the patient's head; press the cheeks away from the impression tray when necessary, so there will not be a fold of membrane underneath; then with the thumbs, one on either side over the center of the ridge, press the cup down carefully but

firmly into position. At the same time direct the patient to thrust the tongue upward and forward. In this way an impression of that portion of the mylohyoid muscle and the cord (frænum linguæ) which is attached to the ridge just beneath the tip of the tongue, is secured, while they are elevated and tense; they will then not disturb the plate while

Fig. 5.

they are in motion, as in speech and mastication. It will sometimes be found that a perfect lower impression will offer considerable resistance to removal, on account of the adhesion and undercuts. Where this is the case, air can readily be admitted by drawing away the lips and cheeks.

For partial impressions, cups of a different pattern are required. Fig. 5 shows the general form of cups used for

such a purpose. Many partial impressions can be readily taken by simply preparing the cups as directed for full impressions. The illustration also shows the position and amount of wax to be placed across the palatal edge. The simplest method, however, is to first take an impression in wax and then remove a layer from its surface, that is from the surface representing that portion of the mouth or ridge where the plate and teeth are to rest; place sufficient plaster at these points to replace this layer of wax, and carefully return it to the mouth.

In taking partial impressions it is important that the surface of the wax should be roughened by cutting grooves, so that the plaster will be thoroughly anchored to the cup. It is also important, when a layer of wax is removed, especially in the interdental spaces where the teeth are to go, that it be of considerable thickness, so that the plaster, should it break, will have sufficient strength to allow of accurate replacement. Again, it is important that the plaster should not set as hard as in full cases, so that the impression will not adhere to the mouth and have to be broken away in pieces; this can usually be avoided by moving the tray up and down, just enough to crack the plaster when it is beginning to set. After fracturing it, the impression should be pressed firmly into place again and held there for a short time—possibly a half a minute—when it may be removed.

Manner of Obtaining Impression in Wax or Compound.—The first step, of course, is to select a properly shaped cup for the case in hand; then look to the secretions of the mouth. If the secretions are abundant, thick or viscid, they should be removed by rinsing the mouth with salt and water. The impression material, whether wax or compound, may then be softened by gently heating over a lamp or Bunsen burner, or, as some prefer, by immersing

in hot water; when the latter method is employed the moisture should always be absorbed from the surface with a towel or napkin before manipulating with the hands.

The cup should then be filled with the softened material and impression taken. The position of both patient and operator, and the manner of introducing the cup into the mouth is the same as has been directed for taking impressions in plaster. But it must be remembered that these materials will not flow as plaster does, so it is very necessary that firm and steady pressure should be used against the cup in order to secure a good impression of every desirable part, and to aid in this the patient should be directed to draw down the lip, and the impression material should be pressed in all around above the rim, the pressure on the surface of the cup must at the same time be kept firm and steady. The hardening of these materials may be hastened by dipping the corner of a napkin or a piece of cotton in cold water, and passing it over the surface of the cup. When it is firm enough to remove it must be done with great care, and the direction of its removal must be determined by the position of any remaining teeth, or the projection of the ridge. And though much care is taken the impression is never as sharp as where plaster is used, and there exists such a probability of imperfection from bending or dragging due to undercuts, that plaster should be the material used in all cases possible, the more difficult the case the more reason why it should be employed.

Preparing the Vacuum Chamber.—In full cases it is not necessary, as a rule, to make a vacuum chamber in the plate. Vacuum chambers are of temporary service only, as they are soon perfectly filled with soft tissue. All that is required to secure sufficient adhesion is to have the plate come in close contact with the palate and ridge at every point, that is, to have the pressure equally distributed. (See carving of models.)

In partial cases, or where for any reason it is desired to use a vacuum chamber, the simplest and one of the best methods is to cut the form of the chamber in the impression before using the varnish. The plaster in this way will be raised at a corresponding point upon the cast, and will have the same form and depth as the cavity cut in the impression. Should it, however, be desirable to change the general shape of the chamber, this raised portion can readily be carved to the desired shape and size. With this form of vacuum chamber there is no danger of displacement or having holes in the plate by the loosening and dropping of pins used to attach the metal chamber forms to the cast.

PLASTER MODELS OR CASTS.

After securing a perfect impression of the mouth, the next important step in the construction of an artificial denture is to obtain from the impression a correct representation of the parts in plaster. This counterpart or copy is called a model or cast.

Manner of Obtaining Casts.—When preparing a cast from a wax or modeling compound impression, it is not necessary to coat impression with any separating material excepting to dip them in soapy water just before pouring the plaster, water is more easily dispaced than air. Mix plaster as for taking impressions, excepting that it should be a little thinner and that nothing is needed to hasten the setting. In partial cases it is often desirable to strengthen the plaster teeth to secure them against accident in handling, especially such as are to be used in adjusting clasps, and those adjoining the space to be filled by the artificial teeth. This support may be given by placing short pieces of stiff wire or ordinary pins vertically in the depressions made in the impression by the teeth, and in

order to support them in this upright position until the plaster is poured, the end of each pin should be slightly forced or imbedded in the impression material in the center of the bottom of each cavity. The plaster should then be mixed and poured; in doing so it should not be poured directly into the cavity formed by the teeth, but a little of the plaster should be placed at a point just back of these cavities, and then gently but hastily coaxed into them by slightly tapping the bottom of the impression cup against the table. In this way the air and water are expelled and the plaster more perfectly fills the cavities, which of course will give more perfectly shaped teeth on the cast, that is they will be minus the "air bubbles" so often seen in such cases. Sufficient plaster should then be added to give to the model a depth of about two inches.

To Separate Cast from the Impression.—The simplest and most satisfactory method of separating the cast or model from the impression is to immerse the impression in warm water until the wax or modeling composition is sufficiently soft to allow of its being readily removed. Or dry heat may be applied to the impression until the same result is accomplished.

To Obtain Cast from Plaster Impression.—The manipulation required in securing a model from a plaster impression is much the same as when wax or modeling compound has been used, though there are a few details which are very essential. There are various methods of preparing the impression, but in this, as in every subject treated, our endeavor is to give the one generally accepted as the best practice; by that we mean the method which has proven most satifactory, not only in our own hands, but to many of the most progressive practitioners and teachers.

Separating Fluids.—Of the materials used for separating, probably the best are shellac varnish, and soapy water. The

shellac is not a parting fluid, but is used to stain the plaster, so that the line of demarkation between the impression and cast will be more clearly indicated. After this has thoroughly dried the impression should be coated, by means of a camel's hair brush, with the soapy solution, which gives it a smooth, glossy surface, ensuring easy separation. Care must be taken, however, to leave none of this solution unabsorbed on the impression or in the imprints of the teeth, or the face of the cast will not be as sharp and smooth as is desirable. This is best removed by washing the surface off thoroughly, when the impression will be ready to receive the plaster for the model.

The same measures for mixing and pouring cast and for strengthening the plaster teeth should be pursued as directed where wax or modeling compound has been used.

A very simple though effective method of staining the plaster is to color the water used in mixing the plaster for the impression with anilin red or rose pink. The latter gives the plaster such a delicate pink color that it is quite unobjectionable to the patient, and at the same time the coloring is sufficient, so that the impression can be readily distinguished from the cast in separating. When this is used the shellac varnish, of course, is not necessary.

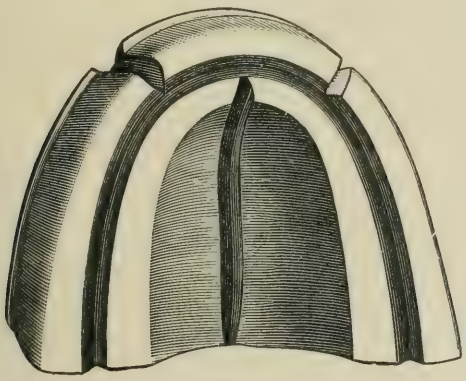
The objections to oil are that plaster will not flow smoothly over an oiled surface, and that it has a tendency to soften the surface of the cast.

Separation.—The manner of separation is more difficult where plaster has been used for the impression material, and requires more care. It is needless to say that one good cast is better than several poor ones, so every care should be taken in separating, and no effort should be made to save the impression for further use, as it would usually be at the expense of the cast should we do so. There are cases, however, both upper and lower, where the mouth is so flat

that they can be readily separated, either by taking the model in the hand and tapping the handle of the cup, or by slipping a wedge-shaped instrument between the impression and cast at its posterior border.

We usually find more or less under cuts, however, and often the ridge is thin and prominent, or we may have a number of teeth remaining. In all these cases, and they represent a large majority, the impression can only be removed with safety, that is, so as not to deface the model, by being carefully broken away piece by piece. The rim

Fig. 6.



of plaster on the outer side of the ridge is first removed; this is best accomplished by removing the cup from the impression, and then cut a groove around the latter at a point directly over the ridge, as deeply as possible without marring the face of the cast, then begin at one corner and break away the rim piece by piece, after which the palatine portion can be readily removed. Fig. 6 indicates where grooves should be cut so that the impression may easily be removed from the cast. When it is desired to prepare a model for permanent preservation, it should be thoroughly dried and then immersed for a short time in a solution of

carbonate of soda; the surface will be converted into carbonate of lime, which will render it hard and durable. Or the model may be boiled in a strong solution of alum. Or add to the plaster from five to six per cent. of powdered alum, or the same amount of ammonium chlorid, before mixing with water.

To retard the setting of plaster, mix with it before adding the water, about three per cent. of powdered althæa root. But where for any reason it is desirable to retard the setting for a half hour longer, about eight per cent. of althæa root should be added. This not only retards the setting of the plaster but enables it to be sawed, filed or turned.

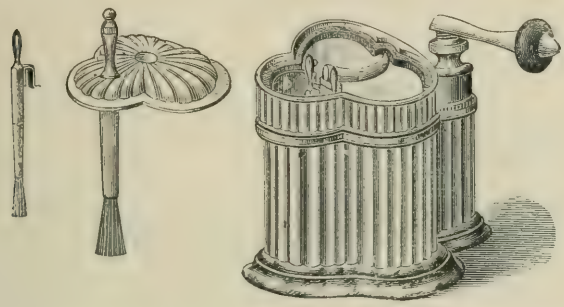
The Separating Fluids are very easily made and are inexpensive. For the soap solution take of castile soap one ounce, and dissolve in a pint of hot water. This solution should then be kept bottled. In preparing shellac varnish, take of pure gum shellac one ounce and alcohol about a half pint; this should be digested over a moderate heat until thoroughly dissolved, when it should be kept securely bottled.

One of the most convenient methods for keeping such a solution free from dust and other foreign substances, and at the same time keep it air-tight, so that the preparation will not become too thick by evaporation of the alcohol, is to use the preparation cup known as the "clover leaf," which is shown in Fig. 7.

Taking the Bite and Antagonizing the Models.—A correct articulation is of as great importance as any other feature in the construction of an artificial denture, for no matter how perfect the impression and model, or how thoroughly and artistically the plate may be finished, if the articulation is not correct the entire piece of work is practically a failure. It is in taking the bite for full cases,

that is, for full upper or lower, or both, that the greatest care is required. By the term "bite," in relation to our subject, is meant the relative position of the jaws with the articulation of the natural teeth, when there are any remaining, with the length and contour of the lips.

Fig. 7.



For Full Cases.—Whether upper or lower, or both, a base plate of some firm material, as paraffin wax or a thin sheet of modeling compound, should be accurately fitted on the model, and the edges trimmed to the plate line, that is, so as to clear the facial or lingual muscles or any heavy folds of mucous membrane. If it is a lower case, whether full or partial (but giving greater assistance in partial cases), a semicircle of stiff wire, No. 15 or 16 standard gauge, should be imbedded in the base-plate to give it additional strength for taking the bite and trying the teeth in the mouth. Attach to this base-plate, by means of a hot spatula, a rim of softened beeswax, sufficient to represent (as near as you can judge) a little more than the length and the fullness of the teeth to be inserted. Place this trial plate with rim in the mouth. Note where the wax rim is too full or too long, or *vice versâ;* then remove it, and trim or build up as the case may require, until the proper length, fullness, and contour are attained.. As this wax is to be

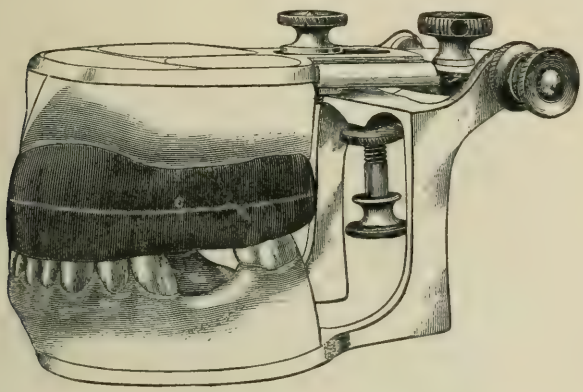
trimmed to the exact length that we wish the artificial teeth to be, it is important to know at this time that the upper anterior teeth should be made about a line *longer than the upper lip*, while the lower are that much shorter than the lower lip. If it is a single case, either upper or lower, the wax plate should now be removed and the articulating border passed over the flame a few times to soften it sufficiently to readily receive the imprint of the antagonizing teeth. It should now be replaced in the mouth and the patient directed to close the teeth gently and lightly against it; note carefully the points of contact, and have it repeated by now directing the patient to close upon the wax in the back part of the mouth, and to swallow at the same time. This last act will usually force the teeth into the wax sufficiently to imbed the cusps and cutting edges. If there is no variation in the points of articulation, it is safe to assume that the bite is correct. The depth to which the cutting edges of the teeth should be imbedded in the wax must correspond to the length of the "over-bite" of the anterior upper teeth. Now mark the median line on the wax rim. This cannot be safely regulated by the center of the lower teeth or by the frenum, as either may be a little to one side or the other, but should be determined by the face alone. A line should be drawn across the wax to correspond as near as possible with the center of the features.

A wax or compound impression of the antagonizing teeth should be taken and the cast from this placed in position, so that the cusps and cutting edges of the plaster teeth may be gently forced into the depressions made in the wax rim by the natural teeth. The two cast with the bite held accurately in position are now securely attached to the articulator, with plaster-of-Paris. Fig. 8 represents such a case.

Where the bite for both upper and lower is to be secured,

the base plates and the wax rims are prepared as before directed. Place the plates in the mouth, the lower first; the proper length and contour should now be secured and the occluding surfaces trimmed, so that they will touch evenly and at the same time upon both sides of the mouth, and the patient directed to close lightly upon the wax *in the back part of the mouth.* By this means, that is directing

Fig. 8.



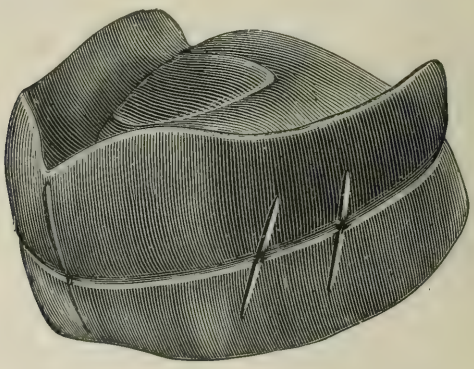
the patient's attention to the posterior part of the mouth, it at once overcomes the tendency to protrude the lower jaw and give a false bite. The median line should then be drawn across both plates and a cross, or two or three oblique lines made on either side; after this is accomplished, direct the patient to open and again close the mouth; note whether these lines are brought accurately together; if so, have the patient bring slight pressure upon them by closing the jaws a little harder, when, if the occluding surfaces have been previously passed over the flame, they will adhere so firmly that they may be readily removed from the mouth together, without displacement. Fig. 9 shows them as removed from the mouth.

The plaster casts should then be carefully adjusted to

these wax contour models, and attached while in this position to an articulator, and the regulating screw in the articulator properly adjusted. By this means the plaster casts will be placed and retained in the relative position of the jaws. This result is shown in Fig. 10 with the wax base plates and bite removed.

For Partial Cases.—When a large partial case is presented, the base plate should be prepared to fit the cast; then a small piece of softened wax should be adjusted in the

FIG. 9.

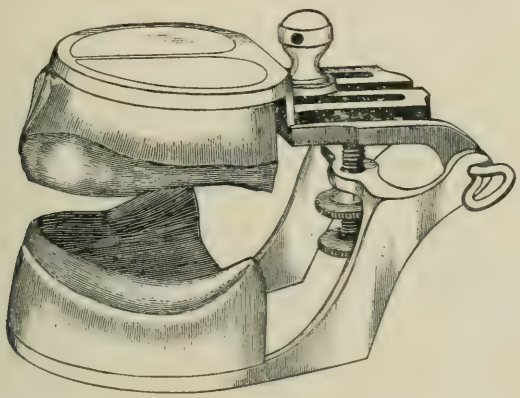


spaces that are to be supplied with teeth. This should be placed in the mouth and the patient directed to bring the teeth carefully together; if this has been correctly done, the bite should be removed and replaced upon the plaster cast. Then a wax or compound impression of the opposing teeth should be taken, and from this a plaster cast secured which articulates with the cast containing the base plate and bite. The two casts should then be carefully secured in the articulator.

Where only one or two teeth are missing in the same locality, it is not necessary, as a rule, to take the bite in this manner. All that is usually required is to secure a cast of the opposing teeth, and an observing eye to note the peculiar-

ities of the case and to aid you in adjusting the casts so that the occluding surfaces will correspond exactly with the articulation of the natural teeth. But where the number of teeth missing is so great, or where for any reason there is any doubt as to being able to articulate the casts in this way, and where the cast is not sufficiently large to require a base-plate, etc., a very simple method is to take a small

FIG. 10.



roll of softened wax an inch or more long, according to the number of teeth lost, place this wax between the remaining teeth, pressing against the teeth on either side of the space, and direct the patient to close the teeth naturally, that is, to bite into the wax until the cutting edges and cusps are brought firmly and accurately together. The wax should now be pressed firmly against the ridge where the teeth are to be replaced, and against the outer, that is, the labial or buccal, surface of the antagonizing teeth. This bite should now be chilled with a few drops of cold water and removed from the mouth. With this guide the casts may now be nicely adjusted in the articulator.

Carving the Model.—In order to secure a close adaptation of the plate at every point—which is necessary to secure

perfect adhesion between the denture and the mucous membrane of the palate—the cast or model should be so carved that the pressure will be equally distributed. Before dismissing the patient after taking the bite, the mouth, therefore, should again be closely examined, and the cast scraped or carved where additional pressure will be required; that is, wherever the tissues of the palate are found to be softer and more yielding than at other points. For instance, take a case that is not unusual, where a prominent, hard ridge is found in the center of the palate. Here it would be necessary to carve away considerable of the plaster on either side where the tissues are softer in order to equalize the pressure, otherwise the finished denture would rock upon the hard point and thus practically prove a failure. In nearly all cases a little carving at the posterior edge, from the plate line forward, will prove advantageous, and in some cases a groove should be cut around the outside of the ridge where the parts are yielding, which will form a raised line or "bead" on the plate just under the margin of the rim. Also when plain teeth are to be placed directly upon the gums, as shown in Fig. 21, the cast should be carved at the points where the teeth are to rest, so that they may set firmly upon the natural gum, and in fact become slightly imbedded in the gum tissue when the denture is completed.

The shade of the teeth should also be taken at this visit; this, of course, should be to match the natural teeth—where any remain—as accurately as possible; but where all are missing, a tooth most suitable in shape, size, and color should be selected. This will be more fully dwelt upon in the following chapter.

THE SELECTION AND ARRANGEMENT OF THE TEETH.

THE ESTHETIC AND PHYSIOGNOMICAL REQUIREMENTS.

In making up the facial features, the jaws and teeth form a very important part. The teeth, standing, as they do, as guards about the entrance to the digestive tract, tell to the thoughtful student—by their size, form, color, texture, and relative position—not only something of the physiological condition of the individual, but of the mental and moral power or weakness. To replace these organs, then, with fidelity will require liberal art culture and the highest order of intelligent discrimination.

This is well expressed by the late Dr. James W. White, who was one of the most intelligent contributors to the literature of dental art, where he says: "No matter how anatomically correct, or how skilfully adapted for speech and mastication, an artificial denture may be, yet, if it bear not the relation demanded by age, temperament, facial contour, etc., it cannot be otherwise than that its artificiality will be apparent to every beholder.

"This law of correlation, harmony, running through nature, attracts and enchants us by an infinite diversity of manifestations; the failure to recognize its demands by art is correspondingly abhorrent to our sensibilities.

"There is a relation between the physical form and the voice, from which we are led to infer in advance the character of the tones which from any given individual may be expected. This law of association, in any case having led us to expect a base voice, the anomaly should a falsetto greet us is almost ludicrous.

"There is a similar relation between other physical characteristics and the teeth. A broad, square face, or an oval;

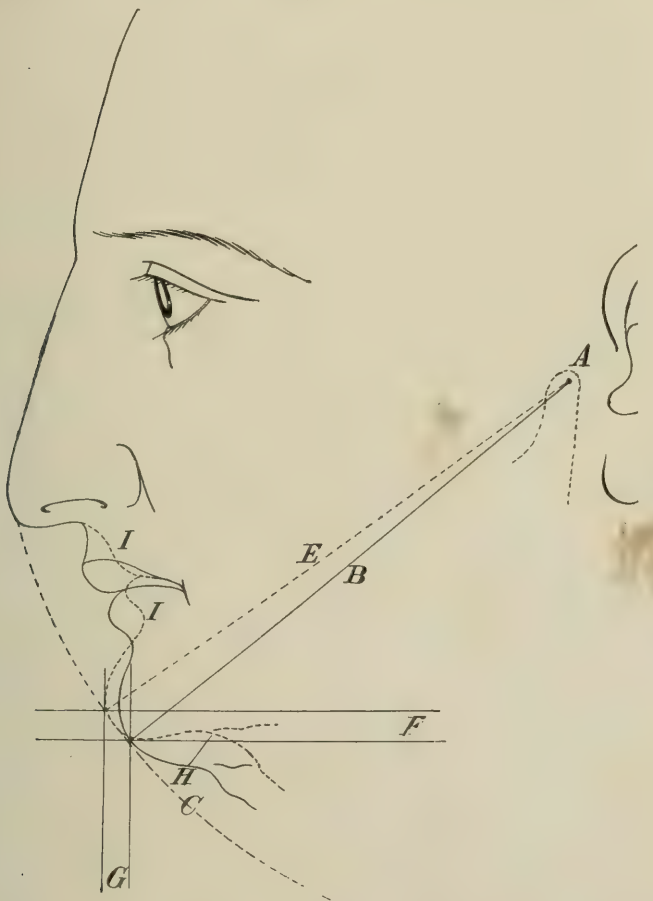
a large, coarse-featured man, or a delicately-organized woman; a miss of eighteen or a matron of fifty; a brunette or a blonde,—these and other varieties present as many different types, with teeth, in size, shape, color, density, etc., corresponding. If, then, teeth correlated in their characteristics to those which nature assigns to one class be inserted in the mouth of one whose physical organization demands a different order, the effect cannot be otherwise than displeasing to the eye, whether the observer be skilled in perception, or intuitively recognizes inharmony without understanding the cause."

Re-posing the Features.—By the term re-posing the features, we include everything necessary to bring each and all of the visible part of the face and mouth into harmony of relation to each other. This necessarily includes the teeth; the relation of the lower to the upper jaw; the lips, cheeks, and the soft parts of the face that have assumed a wrong position by the reason of the loss of the natural organs. After the teeth have been selected with color and form adapted to the individual patient, the final position of the features becomes the most important question. The visible portions of the teeth may be of good form, color, and arrangement, and yet other points of the form may render them unfit for the case. We refer to the placement of the teeth in the mouth in such a position, in relation to the alveolar process, or gums and lips, cheeks and tongue, as to bring the features into correct pose. For this purpose teeth with long porcelain gum attached (gum teeth) will be required in some, while in other cases plain teeth will be demanded, as the space to be filled out to give the features the proper pose be great or small. This relates to full dentures, and even to partial cases.

With the loss of the teeth the general pose of the several parts of the lower face is seriously disturbed.

The teeth in occlusion have held the jaws at a certain position recognized as normal, in which the masseter and temporal muscles which close the mouth are still cap-

FIG. 11.



able of vigorous action. These muscles are much stronger than those which act in opening the mouth. With the loss of the teeth the prop which stopped the lower jaw short

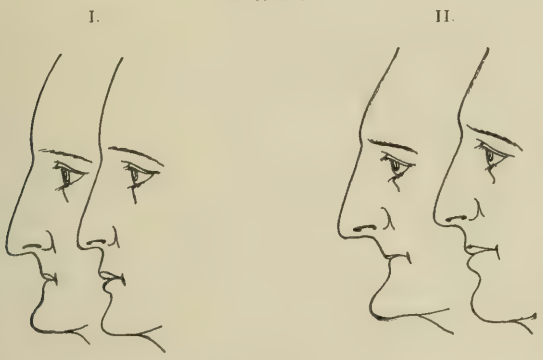
in its motion is removed, and the jaw swings beyond its normal position a distance which varies much in different cases, and usually increases with the time the patient has been without teeth. The motion of the chin is forward and upward, as illustrated by dotted lines in Fig. 11. The condyloid process of the lower jaw hinges in to the glenoid cavity of the temporal bone at *A*. The line *B* is drawn from the joint to the chin, and the dotted line *C* is the curve on which the lower jaw swings when in motion. When the teeth have been lost the lower jaw is free to move farther, and the line *B* swings forward and upward to the dotted line *E*, carrying the chin upward and forward toward the nose, on the dotted line *C*, raising it a distance represented by the horizontal parallel lines *F*, and forward the distance represented by the parallel lines *G*. The lips have been held forward in their normal pose by the teeth. With the loss of the teeth they lose this support and drop back to the dotted lines *I*, *I*, dragging with them the surrounding soft parts and not infrequently pull down the point of the nose. This occurs most frequently in persons who have been without teeth for some years. With the loss of teeth the tongue undergoes a change of form. Being purely muscular, and capable of assuming a great variety of forms, and having been confined upon either side by the teeth, it spreads laterally, as if in endeavor to fill the space. It soon becomes much broader than before, so that more of its bulk comes forward into the upper part of the oral cavity; and the floor of the mouth and submental tissues are raised at the point *H*.

This, with the dropping back of the lower lips, gives the point of the chin a peculiarly sharp appearance. The changes in appearance which the face undergoes is, in some degree, represented in Fig. 12. These changes are, however, as variable as persons, and we refer to the manner

and direction in which they occur rather than of the degree.

Recognizing then that malposition of the features occurs in variable degree, owing largely to the position or prominence of the natural teeth, the amount of shrinkage of the alveolar process, the thinness or thickness of the lips, etc.; the esthetic taste of the prosthetic dentist is brought to the test in the re-posing of the features. Teeth may have been selected that are in every way suitable for the

FIG. 12.



individual case and the symmetry of the arch itself be made correct, but if they are not so placed in the mouth that they will so readjust the pose of the parts with which they are associated that esthetic harmony will be restored, the natural expression of the countenance will not be restored. In this case, although the mechanical execution may be excellent, and the patient may be able to use the teeth in mastication and speaking, it will be a failure in the higher sense of esthetic prosthetic dentistry.

TEMPERAMENTAL INDICATIONS.—The completeness with which the requirements of individual cases are fulfilled depends very much upon the ability of the dentist to properly interpret and apply the basal facts revealed by an intelligent study of the temperaments in relation to the teeth.

In another place, "Temperament in Relation to Teeth," Dr. James W. White, previously quoted, gives many appropriate thoughts and suggestions, the importance of which justifies our quoting at some length:—

"*Temperament* may be defined as a constitutional organization, depending primarily upon heredity—national or ancestral—and consisting chiefly in a certain relative proportion of the mechanical, nutritive, and nervous systems, and the relative energy of the various functions of the body,—the reciprocal action of the digestive, respiratory, circulatory, and nervous systems. The stomach, liver, lungs, heart, and brain—digestion, assimilation, respiration, circulation, and innervation—are all factors in the differentiation of temperament; and according to the congenital predominance of one or the other, and the relative activity of these functions, is the modification of the characteristic of the individual which assigns him to one or the other of the basal or mixed temperaments. Each temperament is the result as well as the indication of the preponderance of one or another of these systems and of relative functional activity. . . .

"Temperaments are readily divisible into four basal classes,—*bilious*, *sanguineous*, *nervous*, and *lymphatic* (see Tables); then again into sub-classes of mixed temperaments, a combination of two or more of the primary divisions. In these combinations one or other of the so-called basal temperaments predominates, and a compound term is used to express the complexity, as, for instance, the nervo-bilious, signifying that the bilious base, the foundation of temperament, is qualified by an admixture of the nervous element, and so throughout the series. . . .

"The value of a practical application of the study of temperament in the practice of dentistry is apparent. That the relation of the teeth to temperament is, as a rule, ignored

THE FOUR BASAL TEMPERAMENTS AND THEIR GENERAL INDICATIONS.

	Indications.	Bilious.	Sanguineous.	Nervous.	Lymphatic.
1	General Form or Framework	Tall, angular, massive; square-built.	Full, firmly-rounded contour development; medium height; robust.	Delicate; slight, but erect and well-proportioned.	Bulky; heavy; clumsy.
2	General Movement	Steady and persistent.	Full, graceful, and easy.	Rapid but fitful in the movements; quick in the sense of frequent.	Unsteady; uncertain; loose-jointed; sluggish; deliberate.
3	Muscular Development	Knotty; prominent; hard; tense; well-developed.	Well-rounded and graceful.	Well-defined; light, but sinewy.	Large, but flabby and ill-defined.
4	Chest and Thorax	Square and capacious; good expansive power.	Well-rounded and capacious; deep and full.	Not broad, but prominent; very expansive.	Large, but lacking in expansive power
5	Voice, Quality of	Strong but inclined to harshness	Smooth; sonorous; full.	Not very strong, but clear, penetrating, and ringing.	Poor in vibration, but often soothing and quieting in quality
6	Complexion and Skin	Brownish-yellow; tense and inclined to roughness; dry.	Florid; smooth; warm and dry.	Abounding in grayish tints; fine in texture and elastic.	Pallid; muddy; moist and cold.
7	Favorable Endowments or Advantageous Indications	Strength, endurance; fortitude; decision; firmness.	Hopeful; enthusiastic; aspiring.	Remarkable recuperative power.	Gift of self control; calm, cool; quiet.
8	Unfavorable Endowments or Disadvantageous Indications	Inclined to melancholy; despondent.	Lack of self-control; impetuous.	Mental fitfulness, and inclined to rapid degeneration or retrogression.	Inertia; low recuperative power in pathological conditions.
9	Cranial Contour	Square forehead and cranium.	Rounding and full forehead and cranium.	Cranium inclined to preponderate over face.	Forehead low and not shapely; often receding and flat
10	Facial Contour	Angular; high cheek-bones.	Round and full.	Delicately oval.	Flat-faced.
11	Hair	Black, and closely curling; inclined to coarse	Golden to light chestnut; slightly wavy	Brown; wavy; fine.	Coarse; straight; drab and sparse
12	Eyes	Average size; black, and strong in expression.	Large; full; clear; round; blue.	Above average in size; dark-brown; perceptive in expression.	Small, expressionless, and grayish
13	Eyebrows	Heavy; strong, and straightly marked	Fairly arched; not well-marked.	Well-marked and arched; finely penciled	Sparse and indistinct.
14	Nose	Strong in outline; Roman.	Straight and shapely.	Finely cut and often delicately aquiline in form.	Flat; alæ heavy
15	Lips	Large and brownish-purple.	Ruddy and full	Fine and grayish-pink.	Large, but not shapely, and pale.

THE TEETH AS INDICATED BY TEMPERAMENT.

General Divisions.	Bilious.	Sanguineous.	Nervous.	Lymphatic.
General Color and Quality of Color.	Bronze-yellow, with strength or power of coloring.	Cream-yellow and inclined to translucency.	Pearl-blue or gray; inclined to transparency.	Pallid and opaque, or muddy in coloring.
General Form.	Large and inclined to angular; rather long in proportion to breadth.	Well-proportioned; abounding in curved or rounded outlines; cusps rounding.	Length predominating over breadth; fine, long cutting edges and cusps.	Large, but not shapely; breadth predominating over length; cusps poorly defined.
Surfaces of the Teeth.	Inclined to transverse ridges and abounding in strong lines; neither brilliancy nor transparency of surface, but slight translucency.	Smooth, or nearly so; elevations and depressions rounded; cutting edges and cusps translucent. Fair degree of brilliancy.	Brilliant and transparent depressions and elevations; abounding in long curves.	Surfaces of incisors devoid of depressions or elevations; opaque and dead in finish, even to cutting edges.
Articulation.	Firm and close; well-locked.	Moderately firm; jaw inclined to rotate in mastication.	Very long and penetrating.	Loose and flat.
Gum Margin or Festoon.	Heavy and firm, but inclined to angularity.	Round and full, as regards both breadth and depth.	Delicate, shapely, and fine; oval in curve.	Thick and undefined in shape.
Rugæ.	Heavy and rugged in shape; squarely set.	Numerous and graceful in outline; not heavy, but well rounded.	Close, not numerous; small and long.	Sparse and flat.

by those engaged in prosthetic dentistry is evident in the mouths of a majority of those who are so unfortunate as to be under the necessity of wearing substitutes for lost natural dentures.

"The trouble usually, is not with the manufacturers; they supply the demand. The fact is, the requirements of the law of correspondence have not been sufficiently studied by the profession. The first study of the dentist who aspires to the dignity of artist, when proposing to restore a lost tooth, should be how to restore the natural appearance of his patient, and this can only be effected through an appreciation and observance of the temperamental characteristics and the law of correspondence or harmony. Age and sex may somewhat modify the requirements in a given case, but the basal fact on which he should proceed is temperament. A failure to recognize its demands will result in failure,—from an esthetic standpoint. A knowledge of the distinguishing characteristics of the various temperaments and the style of teeth which conform to nature's type in the physical organization marks the difference between the dental mechanic and the dental artist."

From the foregoing remarks we gather the following points for special notice:—

In Selecting the Teeth.—*First,* their shape and character, whether the sides of the teeth are parallel or divergent; whether their face is flat or curved; whether they are thin and translucent, or thick, opaque, and massive.

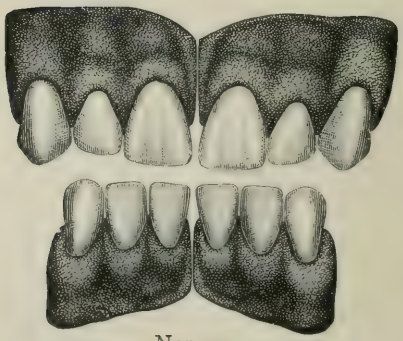
Second, their size; that is, their width and length and the relative width and length of the anterior teeth. Fig. 13 illustrates typical gum-sections for the four basal temperaments.

Third, their shade. Where all the teeth are not lost, and the remaining teeth are in good condition, an effort should be made to match the natural teeth as accurately as

possible. Where only one or two teeth are missing it is better to select several and match them in the mouth, as we often find that two teeth may closely resemble each other, yet when tried in the mouth it is seen at once that, though little different in color or tone, one is far better than the other. Where full sets are required, the age and temperament of the patient should be the principal guide.

FIG. 13.

Bilious.



Nervous.

Fourth, the position of the pins. Pins are arranged transversely and perpendicularly, and are known as cross and straight pins, respectively. In metal work, that is, for metal plates or crown- and bridge-work, straight-pin teeth should be used wherever possible and the cross-pins

avoided, for the following reasons: (1) The position of the pins in the cross-pin tooth weakens the body of the tooth. (2) Their position makes the strain upon the tooth greater, as it gives increased leverage between the pins and the cutting edge. (3) There is less liability of cracking the teeth in soldering the straight-pin tooth as so much metal is not brought at one point.

Sanguineous.

Lymphatic.

In Arranging the Teeth.—*First* in importance is the center or median line, which is regulated by the line upon the wax bite. The median line should not be indicated at one point alone, say at the cutting edges, and the teeth slanting to the right or left, as is frequently seen, but it should

exactly divide the space between the central incisors for their entire length.

Second, the slant of the teeth. The teeth, especially those in the anterior parts of the mouth, beginning with the central incisors, should lean slightly toward the median line. The slant should usually be the greatest in the central and lateral incisors, and by slight variations the teeth may be given a more natural appearance. Much judgment and artistic taste may be displayed in forming the slight irregularities. Care should always be taken not to overdo it, so as to give the mouth a crowded and confused appearance.

Third, the relative length. The relative length should be shown by the articulating wax models. This wax, however, should be removed and laid to one side, where it can be kept in sight as a guide, and then after comparing the teeth with wax, as to length, etc., they should be adjusted by the eye. The wax bite in this way is preserved for future use if necessary. It is always better to retain this, as well as the antagonizing casts in single or partial cases, until the plate has been satisfactorily inserted.

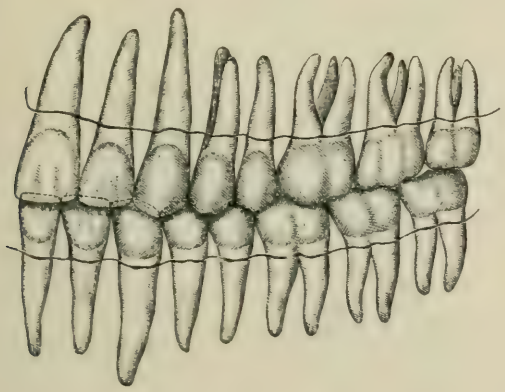
Fourth, the re-posing of the features. The wax models should act as a guide in this as in regulating the length of the teeth. If they were carefully and accurately formed when taking the bite, they would faithfully express the needs of the case in restoring the features. And with an observing and critical eye the operator should not only be able to give the teeth their proper length and fulness, but by building up and carving the wax about them, be able to at least fairly reproduce the lost portions of the facial contour. In doing this the expressional value of the teeth should always be kept in mind.

There are so many points of expressional value in the arrangement of the teeth, that it is always better to try them in the mouth before they are fully arranged, and note

any changes that may be necessary to make them harmonize with the general features of the patient.

Fifth, the articulation. The most important point to bear in mind in articulating the teeth is the normal articulation of the natural teeth. The student should study the wonderful mechanical adaptability of these organs whenever the opportunity is afforded. Fig. 14 is a typical illustration. Observe that all the teeth except the inferior

Fig. 14.



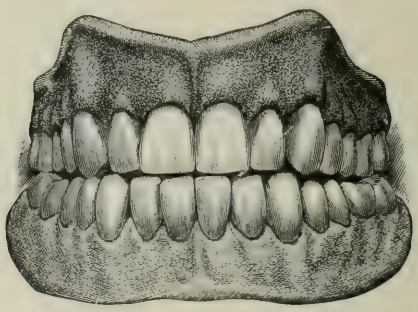
central incisors and the superior third molars have two antagonists in articulation.

In arranging the teeth upon the wax plates, some prefer to adjust the inferior incisors first, while others claim that the superior central incisors should first be set in position. The latter is doubtless the best practice, though it is a point of small consequence if the proper result is obtained. In arranging the posterior teeth it is important that the inner cusps should occlude as perfectly as those of the outer or buccal surface. The greater pressure should usually be brought upon the bicuspids and the first molars; and this bite should be perfect, that is, these teeth should touch evenly and at the same time upon both sides of the mouth.

Such an articulation may be more thoroughly secured by removing the sharp points from the cusps of the teeth. This will also largely overcome the "clattering" so often noticed in artificial teeth.

Faulty Articulation.—When, in a finished denture, the articulation is found to be slightly faulty, the false touching points can readily be recognized and removed with the corundum wheel. When, however, the articulation is found to be so far out of the way as not to permit of satisfactory correction, the entire denture should be reconstructed. This

FIG. 15.



occasionally occurs to the inexperienced, and should prove to them a wholesome lesson. It is always better, as has been previously suggested, to try the teeth in the mouth while they are yet on the wax plate, when any imperfection can be easily remedied.

Shaping the Cutting Edges.—In articulating the teeth, particularly those in the anterior part of the mouth, it is frequently advisable to so cut and shape the edges that they could hardly be recognized as the same teeth.

Take, for instance, a person of the sanguine temperament. Nature gives such an individual teeth that are well proportioned, abounding in curves arranged in a full, round arch, with an articulation that is moderately firm and corre-

sponding generally to the contour of the face. The natural occlusion being nearly on end, the front teeth would be found much worn away by the time the patient would be apt to need artificial substitutes.

Fig. 16.

Fig. 17.

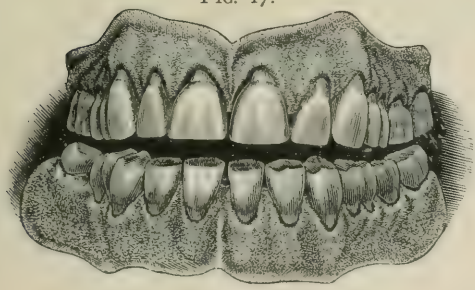
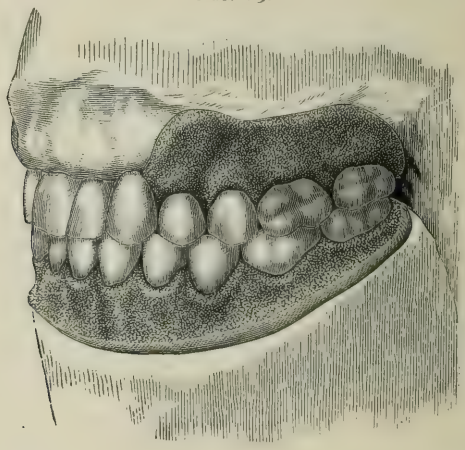


Fig. 18.

Imitating this worn or abraded condition gives the artist further opportunity to display his skill. After selecting teeth that meet the requirements as nearly as possible in

size and color, it is possible, as has been suggested, to so change them by judicious grinding as to give a more harmonious expression to the mouth. This may be accomplished with either plain or gum teeth, but more thoroughly where plain teeth are admissible, that is, where the lip is long enough to conceal the rubber above them. Or, a very natural appearance may be given by securing the teeth at the depots before they are baked, and carve and stain them according to the requirements of the case in hand.

FIG. 19.



Many other points in enhancing the appearance of artificial teeth will suggest themselves from time to time to the thoughtful student. The accompanying illustrations, Figs. 15 to 19, inclusive, are given as typical studies.

Jointing Gum or Block Teeth.—By the judicious grinding of the joints in gum teeth, whether single or arranged in sectional blocks, the proper shape and contour may be given to the denture. But these teeth are not susceptible to as natural and artistic arrangement as the plain teeth. The latter, however, can only be employed where the teeth are to rest directly upon the natural gums as shown in

Fig. 19, or where the lips are of sufficient length to entirely conceal the gums.

When gum teeth are used every care should be taken to so grind the joints that their surfaces will come in perfect contact, and not, as is so commonly practiced, make V-shaped spaces. As each block is thus ground, it should be secured to the trial plate, and so on until all the teeth are in position. The wax plate should then be neatly shaped to resemble the finished plate, when it is ready to be tried in the mouth. Then after making alterations, if necessary, the plate should be replaced upon the cast and secured by passing a hot spatula around its edge, which will prevent the plaster in flasking from running between the plate and the cast.

The practice of packing ill-fitted joints in order to make them impervious to the rubber and to hide poor workmanship, is a very poor expedient, as in a short time these materials will yield to the action of the fluids of the mouth, when the joints will become receptacles for the secretions, and soft particles of food. There is nothing that will so surely and effectively exclude the rubber as *accurate jointing* and *careful packing of the rubber.*

FLASKING, VULCANIZING, AND FINISHING THE RUBBER BASE.

Before entering upon a study of the manipulation of rubber as a dental base, we will consider the composition of the different rubbers used for this purpose. The bases of these compounds is caoutchouc, commonly called India rubber or gum elastic.*

* **Caoutchouc** is a milky, concrete juice, obtained principally from the Siphonia elastica, or Siphonia Cahuchu, a South American tree. It is obtained by tapping the tree, and is of a yellowish-white color, but

After the crude substance has been passed through a triturating machine it is thoroughly washed and dried to remove any foreign substances; it is then melted and sulphur and the coloring matter added. It is due to the presence of the sulphur that the rubber hardens when brought in contact with heat (vulcanization). The more sulphur added, the harder the product. Manufacturers as a rule do not make their formulæ known, but the following, selected from those of the late Professor Wildman, are thoroughly reliable:—

RUBBER COMPOUNDS.

Red.		Black.	
Caoutchouc,	48 parts.	Caoutchouc,	48 parts.
Sulphur,	24 "	Sulphur,	24 "
Vermilion,	36 "	Ivory Black,	24 "
Pink.		**White (Grayish).**	
Caoutchouc,	48 parts.	Caoutchouc,	48 parts.
Sulphur,	24 "	Sulphur,	24 "
White Oxid of Zinc,	30 "	White Oxid of Zinc,	96 "
Vermilion,	10 "		

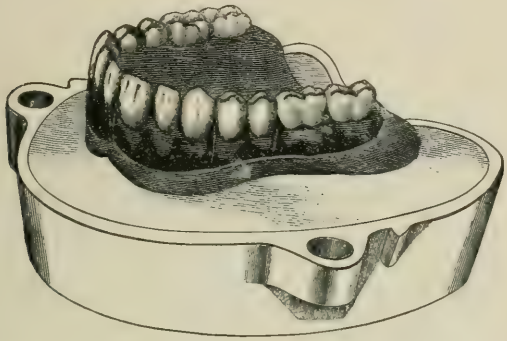
Flasking.—After removing the cast and denture from the articulator, they should be placed for a few minutes in cold water, so that the plaster will become saturated, and thus prevent its absorption of the water from the newly mixed plaster in flasking, which would in a measure prevent the proper adjustment of the cast.

When the plaster has been thoroughly mixed (to a creamy consistency) fill the lower part of the flask about half full and introduce the model, slightly inclined at first, then press it down to a horizontal position, well imbedded

gradually grows darker upon exposure. It takes its common name, rubber, from the fact that it was used many years simply as an eraser of lead pencil marks. It is insoluble in water or alcohol, and is remarkable for its elasticity. Caoutchouc melts at 248° F., and remains in an unchangeable fluid state up to 500° F.

in the plaster. By this means the air is excluded, which would not be the case if it were forced down horizontally at once.

Fig. 20.



The height of the plaster about the denture determines the division between the two sections of the flask. This is regulated by the character of the teeth invested. If they are teeth (either gum or plain) that rest upon or are embedded in the base plate, the case should be invested to just above the margin of the wax (see Fig. 20). In this way the teeth and nearly all of the wax rim will be embedded in the upper portion of the flask.

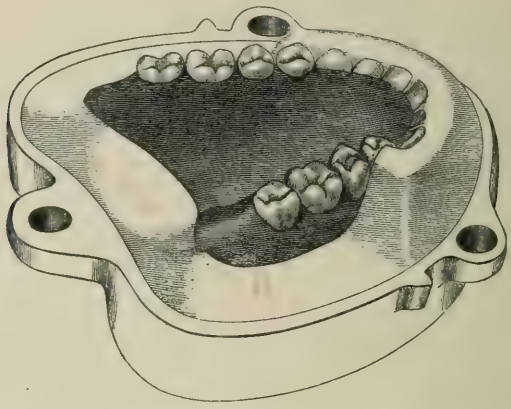
When the necks of the teeth are to rest upon the natural gum, as shown in Fig. 19, the investing plaster should extend to the cutting edges of these teeth so as to retain them in the lower section of the flask. This is illustrated in Fig. 21.

While the plaster is setting, trim the surface up to the shape or slant desired, avoiding undercuts, leaving it as smooth as possible. After it is thoroughly set, varnish this surface with shellac, and when dry give it a thin coat of oil or the soap solution. Care should be taken not to allow the varnish or oil to come in contact with the teeth.

The ring or upper section of the flask should now be

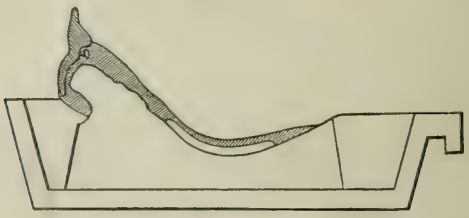
placed on the lower portion which contains the teeth. A perfect joint should be secured between these two sections, the plaster should be mixed as before, and poured into this ring while in position, jolting the flask at the same time

FIG. 21.



to induce the plaster to run around the teeth perfectly and to force the air out. After the flask is well filled, the top piece should be placed in position and forced home, which will drive out any surplus plaster; this pressure should be continued until the plaster has thoroughly set.

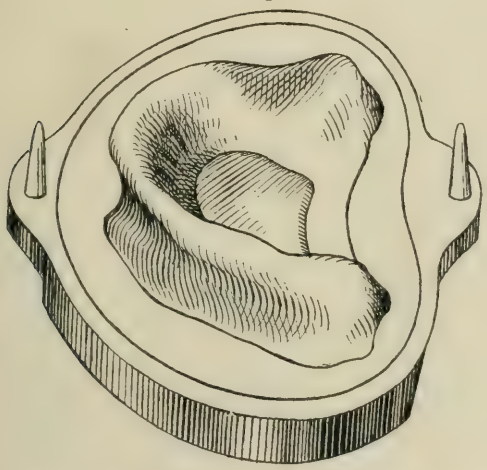
FIG. 22.



Where deep undercuts are present, one of two processes may be adopted. They are well described in the late Dr. Alonzo Beale's article in the "American System of Dentistry," where he says: "First, the plaster in the lower

section may be made to cover the wax rim within half a line of the porcelain gums. This will protect the cast, so that it will not be fractured when parting the flask or when packing the rubber. This method is represented in Fig. 22. Or, the base of the cast may be so trimmed that the undercut will approach as nearly as possible the perpendicular, as seen in Fig. 23. When the latter plan is adopted

FIG. 23.



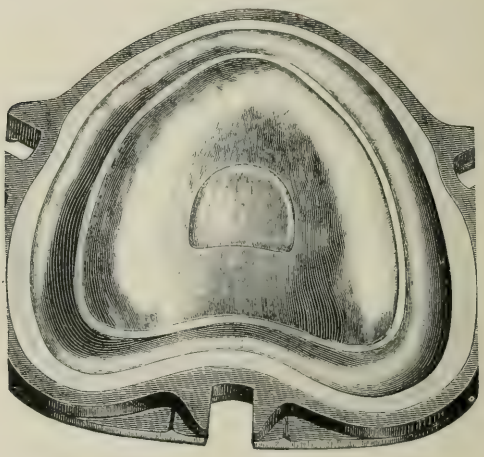
the flask, before opening, should be moderately heated in water to about a temperature of 120° F. Allow it to remain in the water for a few minutes, so that the heat may penetrate to and soften the wax. Then remove the flask and separate the two sections carefully. If these directions are followed, the wax will generally part readily from the teeth and plaster. If any adheres to the pins, it should be carefully washed out with boiling water."

The necessity for removing every particle of wax is due to the fact that its presence destroys the integrity of the rubber and interferes with its vulcanization. It is better, therefore, in all cases, to direct upon the cast a stream of

boiling water, with the flask placed as such an angle that any particles of wax will be readily carried off.

Outlet Grooves or Gates.—The next step is to make grooves or "gates" which will act as receptacles for the excess of rubber. This is done by cutting a groove around the cast, part way between it and the margin of the flask, as shown in Fig. 24. The groove should be beveled from

FIG. 24.



its bottom toward the casts to within about one-sixteenth of an inch of the border. The top of this septum is then slightly scraped. This must be carefully done, as it is desirable to simply trim off the sharp edges and a thin and uniform layer of the plaster from its entire surface, which will more readily allow the passage of the surplus rubber into the annular groove. This method was first suggested by Dr. W. Storer How, in *The Dental Cosmos.*

The old method, and that practiced to-day by many, is to cut radiating grooves about one-fourth of an inch apart, leading from the cast to the larger or annular groove. As Dr. How says of this, the radial gates really defeat the true

objects in view by affording too free an escape of the softened rubber, thus preventing that condensation of the inclosed material which is necessary for the production of the best results.

Before packing the rubber the case should be thoroughly dried and the cast coated with something to prevent the rubber from penetrating the pores of the plaster and adhering to its surface, thus giving a smoothness to the palatine surface of the plate. For this purpose tin-foil or liquid silex is generally used, but we have found excellent results can be secured by sprinkling lycopodium or soapstone upon the surface of the cast. This should then be thoroughly brushed off with a jeweler's brush or a soft brush wheel, leaving the surface of the model with a high polish.

The case should now be made quite warm, by placing it in an oven or over a gentle flame, which will aid materially in packing the rubber, as it more readily adheres to a warm surface.

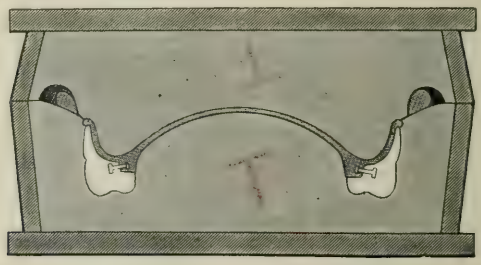
Packing Rubber.—Before packing it is important to see that the mold, instruments used, and the rubber are perfectly clean. Then cut the rubber into narrow strips about an inch in length, and in small squares, to pack around the teeth, also one or two larger pieces to cover the body of the cast. Place these pieces upon a metallic plate (tin or zinc) over a pan of *hot* water. The small pieces of rubber should now be carefully worked beneath and between the platinum pins, with small curved and straight pointed instruments. Then proceed to fill the mold by adding small pieces, one at a time, after each successive piece has been thoroughly impacted, and finish the packing process by adding one larger piece, which should be of sufficient size to cover the palate, with a smaller piece over its center. This will make the center a little fuller than the remainder of the

mold, so that when the sections of the flask are brought together, the rubber, if kept sufficiently hot, will be forced gradually to the margins of the mold, diminishing, thereby, the liability of moving or fracturing the gum sections.

After packing the mold the upper section of the flask should be placed in position, the bolts slipped into place, and the nuts turned down just enough to hold all in their proper position.

The flask should now be placed in *boiling* water for about one minute, then removed, and the nuts turned down carefully and evenly until considerable resistance is offered,

FIG. 25.



when it should be replaced in the boiling water and the process repeated until the two sections are brought securely together. The bolts should not now be loosened until the case has been vulcanized and become cold.

The flask-press, while a very useful instrument when judiciously employed, should not, as a general thing, be used by students, for blocks are fractured, teeth forced out of position, or entire cases are easily and frequently ruined by undue force being exercised in bringing the sections together.

If the foregoing directions have been closely followed, a cross-section of the flask would have the appearance shown in Fig. 25. The annular grooves shown upon either

side would, however, probably be at least partially filled with surplus rubber.

Vulcanizing.—That the student may understand the chemistry of the process of vulcanizing, and as an introductory to the more general considerations of the methods and appliances employed for that purpose, we quote as follows, from a paper by F. A. Boeck, of Berlin, Germany, which was translated by Dr. Louis Ottofy: "Chemistry teaches that all vegetable products, such as wool, starch, the leaves and sap of plants, consist of four elements—oxygen, nitrogen, hydrogen, and carbon. In no plant, or the product of a plant, is carbon absent, and it is mostly in connection with hydrogen and oxygen, whereas nitrogen is but seldom present. From these few elements nature has produced all that earth possesses of vegetable growth, the variety and difference being sometimes only the different proportion of union of the elements, or the addition of a small amount of acids, bitter substances, coloring matters, or salts. Rubber consists only of the above elements, namely, CH; it belongs, therefore to the class known as the hydrocarbons, and to that class of these in which C predominates. It is interesting to notice here that the change from the soft to the hard, as is the case with rubber, is the property of all vegetable products. We know that the change takes place by the application of heat, that hydrogen sulphid (HS) is formed, and that the process takes place during the exclusion of air. This process is chemically the same as takes place in the dry distillation of wood, in the changing of wood into coal, and of resin into amber. If wood is heated in the open air it burns; the same is the case with rubber, only that the latter burns slower on account of its larger percentage of C. If wood is, however, heated in the absence of air, as is the case in making illuminating gas, quite peculiar substances are

eliminated from the wood, the illuminating gas, which escapes, and three substances a watery pyroligneous acid (wood vinegar), a thick, viscid liquid (wood tar), and a solid mass (charcoal).

"The wood tar is, like rubber, of a resinous nature; it consists of the oil of wood tar and a liquid substance, burnt resin. Both become hard on cooling; the former is the well-known paraffin, the latter the equally well-known pitch.

"The rubber undergoes similar changes. If it is heated while excluded from air, as is the case in vulcanizing, there escapes (as in the case of wood, illuminating gas), the hydrogen sulphid, and there remains a plastic, which hardens on cooling, as in the case of pitch or paraffin, and we have our hard rubber.

"If we think over this subject, it becomes clear to us why sulphur is added to the rubber. By dry distillation one or more equivalents of hydrogen separate from the mass and remain gaseous, or unite with other substances present and form a liquid, thus leaving behind a hard substance, which consists mainly of C. It is well known that the hardest substance, the diamond, is pure C. The more equivalents of H that remain, the softer is the substance, as in the following scale: coal, resin, pitch, axle grease, oil, ethereal oils, gases. The same is the case in the reversed order. If, from the soft rubber, hard rubber is to be made, it is necessary to remove from it one or more equivalents of H. This is the case in dry distillation. If there is no dry distillation, if the rubber was heated under free admission of air, the C would immediately unite with the O of the air, forming carbonic acid, combustion would take place, even though it would be slow and difficult. This cannot take place when the air is excluded; the carbon remains unchanged, whereas the H finds a substance with which it is more willing to unite at a high temperature.

This substance is the S, and the union of these forms HS, which is well known to us by its odor. When this union has taken place a chemical change has been accomplished, a new substance has been produced, the gas escapes; the remainder, the product of the distillation, contains less H than the raw rubber, and on cooling, like pitch, it becomes a harder substance by its containing more C than before.

"My hypothesis, therefore, leads me to the following conclusion:—

"The hardening, or so-called vulcanizing, of rubber is the changing of caoutchouc into a resin-resembling substance by *the process of dry distillation, and, namely, by the removal of one equivalent of H.* The addition of S serves only as a base, which is indifferent toward C, but unites with H by virtue of a strong chemical affinity existing between H and S, which forms a new compound, HS, which escapes as a gas."

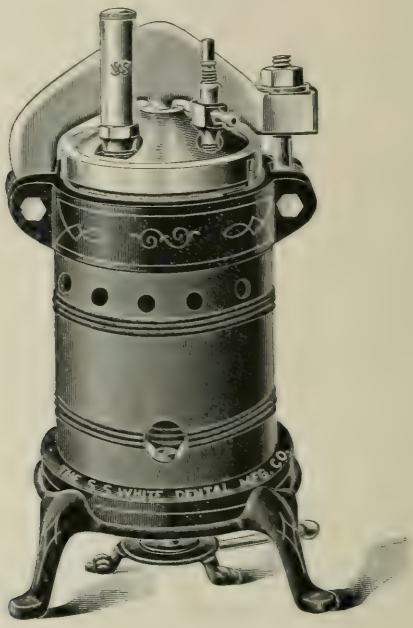
Appliances Used.—The apparatus in which the rubber (prepared and flasked as has been directed) is hardened by the action of heat is known as a vulcanizer. It consists of a copper boiler with a screw top, having connected with it a steam gauge or thermometer for regulating the amount of steam necessary to vulcanize the rubber; the steam gauge is no doubt the safest and most reliable. It is also supplied with a safety-valve or blow-off, to allow the escape of steam and prevent explosion when, from negligence, it should become over-heated. There are numerous forms of vulcanizers upon the market; the one known as the Mann vulcanizer is shown in Fig. 26.

This vulcanizer is given, ready for use, in Fig. 26. Its simplicity is shown in Fig. 27. *E* indicates the collar of the bowl, slotted to form a bayonet joint for locking pin of jacket collar; *F*, the guide pin for its lid; *G*, the slot for the

guide pin; *H*, safety cap; *I*, the blow off. It is altogether a most simple and convenient vulcanizer.

Methods Employed.—After the flask has been carefully packed and closed, place it in the vulcanizer with water

FIG. 26.

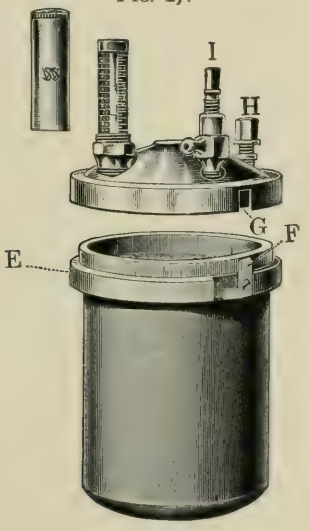


enough to fill the boiler about one-third full, not more. If two or three cases are to be vulcanized at the same time, the same amount of water is sufficient. Place the top of the vulcanizer in position and screw down. Light the lamp or gas and regulate it so as to require a half hour to raise the temperature to the vulcanizing point, 320° F., or 120 pounds pressure by steam gauge. This is, of course, for ordinary work; where for any reason the rubber is unusually thick, the time for running it up should be extended to one hour, or an hour and a half, or more, according to the

thickness of the mass, *as the heat if run up too rapidly will cause the rubber to become spongy or porous.*

When the vulcanizing point is reached the flame should be slightly lowered, so that the temperature will remain uniform throughout the operation. *The time required* to

Fig. 27.



effect vulcanization is usually *one hour from the time the heat reaches the vulcanizing point.* When this time has expired, cut off the flame and allow the vulcanizer to cool to at least 200, when, if necessary, it can be hastened by placing it in cold water. Certain advantages are obtained by allowing the cooled flask after the vulcanization to remain unopened for at least *several hours.* It is claimed that a molecular accommodation of an annealing character thus occurs, with a consequent diminution of liability to warp the plate or break the porcelain section. The long-continued retention of the denture on the model within the

flask tends also to keep the plate in shape until its form becomes permanent; whereas a quickly cooled and immediately finished denture may surprise the dentist by unaccountably changing shape, or by showing cracks in the gum section; in fact, either of these serious defects may result after the denture has been hastily finished and the patient dismissed only to return in a few days with dissatisfaction, because of the meantime occurrence of the defects. It is worth while to *take time to save time.*

The Finishing Process.—When the plate is removed from the flask, all adhering plaster should be carefully detached with a pointed knife, after which it is thoroughly cleansed by the use of a stiff brush and water. The rubber should then be reduced to the desired thickness and shape by the use of scrapers, files, lathe-burrs, and chisels. Fig. 28 represents some of the standard forms of these tools.

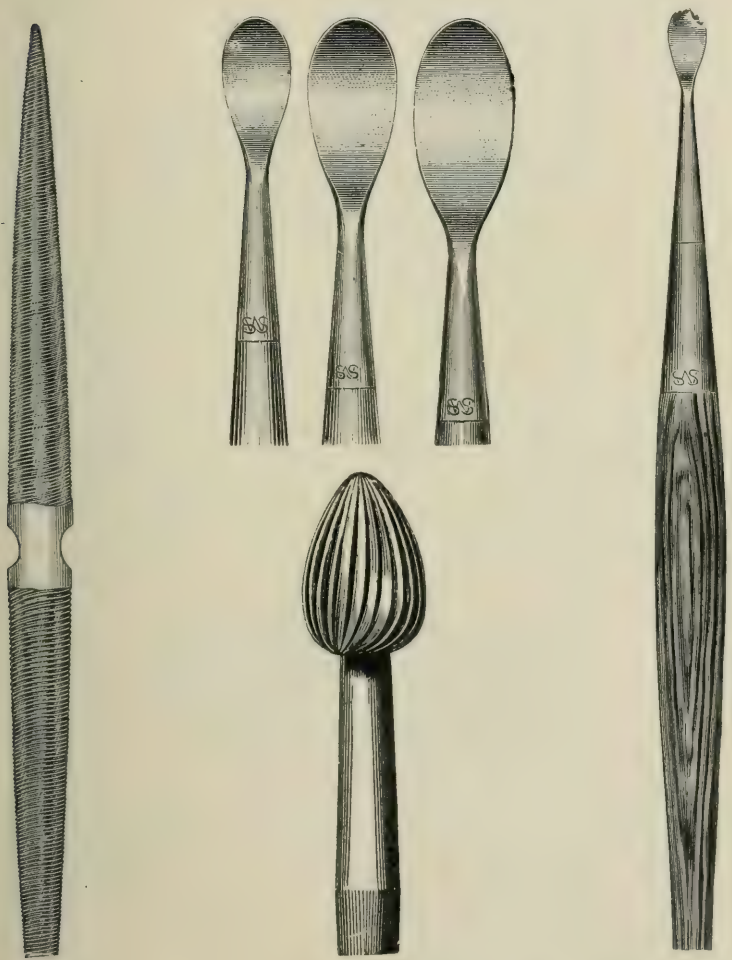
After this is obtained and the surface of the rubber is rendered somewhat smooth and uniform, fine sandpaper is employed to remove the marks and scratches left by the use of the tools. The final finish is then given by first using finely pulverized pumice-stone, on felt or cork wheels or cones, driven by a lathe; this will give a smooth surface. The case should then be washed, when the polish is given by prepared chalk or whitting, applied upon a cotton or soft brush wheel. In using the polishing materials they should be kept freely saturated with cold water throughout the operation. The denture should then be thoroughly washed, when it will be ready for insertion in the mouth.

Pink Rubber Gum.—In the construction of a denture, where "plain" teeth are used and where the artificial gum is to be made of pink rubber, the best practice is as follows, which we quote from the late Dr. Alonzo Beal's teaching:—

After vulcanization, enough of the rubber surface representing the gum should be removed from around and be-

tween the porcelain teeth to allow space for a thin layer of pink rubber. The surface thus exposed should be roughened and trimmed out well between the necks of the teeth,

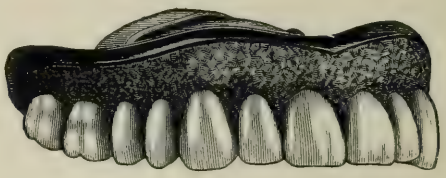
FIG. 28.



as shown in Fig. 29, and then coated with a solution of red rubber dissolved in chloroform. This solution should

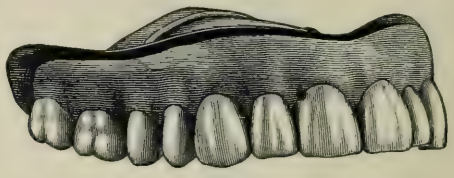
be about the consistency of thin cream. A strip of pink rubber large enough to cover this whole surface should be softened over boiling water and pressed tightly against the red rubber plate, care being taken to force it well in between the teeth, using a smooth, clean instrument for the purpose.

Fig. 29.



To vulcanize this it is not necessary to flask the denture in the usual manner. Wet the plate and place plaster-of-Paris in the palatal surface; fill the flask with plaster and embed the denture in it, and place the lid on. When the plaster is hard, introduce the bolts, and vulcanize thirty-five minutes at 320° F. After cooling remove the flask and carefully separate the plaster from the denture. The plate should be trimmed and polished in the usual way. When

Fig. 30.



polished and thoroughly cleaned the pink rubber may be bleached, and thus rendered brighter, by placing the denture in the sun in a covered glass vessel partially filled with alcohol. All trimming should be completed before bleaching, as only the surface of the rubber is changed in color. Fig. 30 shows the finished case.

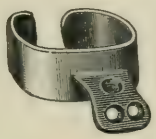
Gold Backing and Tongue.—In partial cases where the bite is so close that the antagonizing teeth come so near

the gum that the thin neck of rubber running from the plate to the tooth or teeth would be too frail to support them, teeth with gold backings and tongues should be used. In preparing such a tooth, select a suitable plate tooth and grind it to fit the plaster model; then fit the backing and tongue to the tooth, arrange them upon the cast to secure the proper bend and angle for the tongue (see Fig. 31), cement them together, invest, and solder.

That portion of the gold plate to be embedded in the rubber should have small gold or platinum pin-heads soldered to it, or it should be perforated in several places as illustrated,—the latter is probably the best practice,—to secure a better union between the gold and the rubber.

Fig. 31.

Fig. 32.



Gold Clasps.—In attaching gold clasps to rubber plates the same method can be employed, that is, by either attaching small pin-heads or perforating the gold tongue which is to extend into the rubber. (See Fig. 32.) In making these attachments they should be so arranged that they will be well embedded in the rubber when the plate is finished. In such cases care must be taken in packing the rubber about the clasps. The space between the pins or tongue and the cast should be packed well with rubber, so that when the flask is closed the force will not displace the tooth or clasp.

Beaded or Grooved Dentures.—For the exclusion of air and moisture from between the artificial denture and mucous membrane of the mouth* a bead may be carried

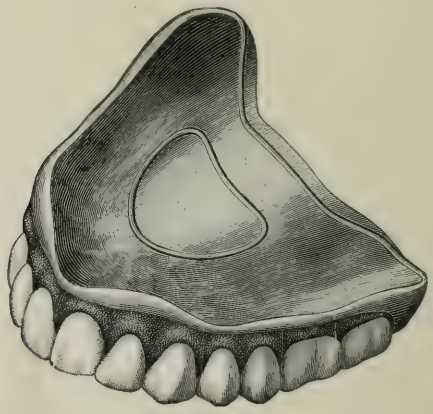
* First recommended by Dr. W. Storer How, of Philadelphia.

continuously around the outer portion of the cast, just inside of the plate line. In many cases this results in an

Fig. 33.

increased adhesion; especially is this so in mouths having flat or soft surfaces. This method is shown in Figs. 33 and 34.

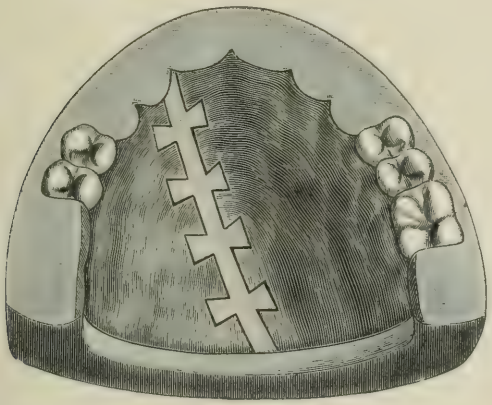
Fig. 34.



Repairing.—One of the most frequent repairs we are called upon to make is a fracture through the center of an upper partial denture, the break extending from the region

of the central incisors backward. The method of repair in such cases is quite simple, consisting in first accurately adjusting the two parts of the plate and fastening them in their correct relation to each other with adhesive wax or shellac. This should be dropped over the entire length of the crack by an assistant, while the sections of the plate are being held in correct apposition. Plaster is then mixed and poured into the plate, forming a cast of the palatine surface of the mouth. After this hardens sufficiently, the wax or shellac is removed, which permits the sections of

FIG. 35.



the plate to be taken up separately. The line of the fracture is now cut out or enlarged upon either side with a large bur revolved by the dental engine, or it may be accomplished with a file or saw. Dovetails are then cut on either side with a jeweler's saw, and the sections replaced upon the cast. The work at this stage is shown in Fig. 35.

The openings between the two halves and the dovetail spaces are then covered with wax, the case invested in a flask in the usual way, the flask reopened, and wax removed. The space between the two halves, with the dovetailed

spaces, are then carefully packed with rubber, when it is vulcanized and finished in the usual way.

The old method of "under-cutting" in repairing rubber plates is unnecessary, a perfect union being obtained in such cases if the surfaces of contact are freshly cut, absolutely clean, and properly roughened.

CELLULOID AS A DENTAL BASE.

In taking up the study of celluloid, Dr. Richardson in his treatise upon "Mechanical Dentistry" says: That celluloid possesses many important qualities which commend its employment as a base in preference to rubber can hardly be questioned. It is more in harmony with the soft tissues of the mouth, more cohesive in texture, approximates more nearly the natural gum color, contains far less vermilion pigment in its composition, and is less objectionable by reason of the comparative cleanliness accompanying its manipulation.

The chief objection urged against celluloid as a base is its low power of transmitting caloric, but it is believed to be less objectionable in this respect than rubber. Both are poor conductors, and the soft tissues of the mouth in contact with either suffer, in some degree, as a consequence of this property.

Celluloid, as at present produced and when properly manipulated, does not, in any appreciable degree, undergo change of form after molding by warping either in or out of the mouth, as was formerly the case, nor, it is believed, does it absorb the oral secretions. It loses somewhat the freshness and clearness of its original pink color after having been in use for some time, in many cases in a very marked degree.

Though not bearing so perfect a resemblance to the com-

plexion of the healthy gum tissue as a good porcelain imitation, yet the near approximations of celluloid to the desired color makes the use of single plain teeth admissible for permanent dentures, and this is unquestionably its crowning merit, and makes it desirable as a so-called cheap base. The indiscriminate and almost universal employment of block or sectional gum teeth in connection with rubber has, it may be safely affirmed, done more to degrade the prosthetic department of dental practice than all other causes combined. The optional arrangement of each tooth to meet the requirements of special cases in respect to expression, articulation, and antagonism is one of the absolute and indispensable requirements of a perfect artificial denture.

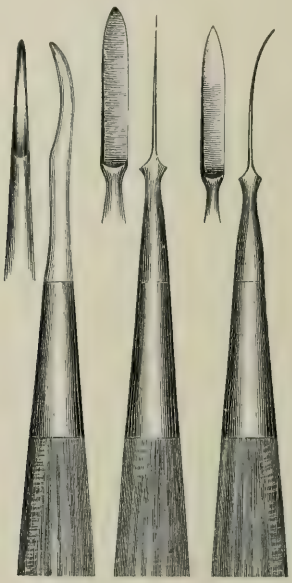
Composition.—Celluloid is composed of pyroxylin,* camphor, oxid of zinc, and vermilion in proportions of about 100 parts of pyroxylin, 40 of camphor, 2 of oxid of zinc, and .06 of vermilion.

Manner of Preparing Cast.—It is necessary to have a harder and stronger cast than for rubber work. This is due to the inferior plasticity of celluloid when exposed to the heat, and the consequent greater amount of pressure required to mold it. To secure these important qualities, the very best hard-setting plaster should be used, or a small quantity of marble-dust may be mixed with the plaster. A metal cast, however, will give better results, especially in case of deep undercuts. In this case block-tin or Babbitt metal may be used, and can be poured directly into the plaster impression. The cavity for the vacuum chamber should, of course, be cut in the impression before the metal is poured.

* Pyroxylin, commonly known as gun-cotton, is made by macerating cotton wool—though linen, hemp, etc., are sometimes employed—in a strong mixture of nitric and sulphuric acids for 15 hours, when it should be washed thoroughly and dried. The proportions are: cotton-wool, ½ oz.; nitric acid, 3½ ozs.; sulphuric acid, 4 ozs.

When metal is employed, a shell is more advantageous than a solid cast; and a plate, where there are any considerable undercuts, can be more readily detached from the former. But before the cast is run, whether it be from metal or plaster, the vacuum chamber, if used, should be carved in the impression.

Fig. 36.



To Make a Hollow Metal Cast.—Prepare the impression as instructed for running cast, or else secure mold in sand from plaster cast, then fuse pure block-tin and pour in the usual manner. The metal cools first at the surface; by taking advantage of this fact and, after waiting a few seconds, inverting the mold and quickly pouring out the central fluid, a thin metal shell can be secured. When obtained it can be filled with plaster, which will form, in fact, a metal-faced plaster cast. When the case is finished and the plaster removed, the edges of the shell may be

drawn in with a pair of pliers, which will allow it to be readily removed from the undercut spaces.

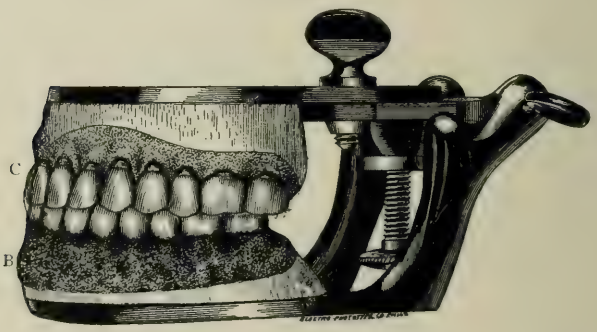
The manner of taking the bite and articulating the case, as well as the arrangement of the teeth, is precisely the same as has been directed for rubber work; more pains is taken, however, in carving and modeling.

Carving.—Dr. W. W. Evans, in the "American System of Dentistry," writes upon the subject as follows: "It is a very simple performance (carving) if we only study a little from nature—take a few impressions of natural gums and teeth in health and in disease, regular and irregular, with spaces from lost teeth and so on. With models of this kind before us, and a remembrance of the face of which we intend to restore the features, the case is not a difficult one. I use in my own carving three little double-end tools, represented in Fig. 36, the uses of each of the points of which I will now explain. Fig. 37 presents a full set of teeth in process of carving, the lower half, shown by B, having on it the rough wax, as dropped there carelessly while grinding and adjusting the teeth, the upper denture, at C, showing where the wax had been cut away from the teeth in scallops by the straight-bladed knife of carver No. 2, and roughly shaped up with the spoon of the same instrument. Next is used the smaller spoon-end of No. 1 to form the fossæ or depressions lying between the roots, and the curved knife-blade of the same to go around the teeth on the palatal surface.

"Having carved the wax in this way, forming festoons or exposing roots, as the case may require, take a spirit lamp with a small flame and an air-bulb, which is better than a blow-pipe, and by gently puffing upon the wax smooth away the rough, irregular projections while retaining the larger undulations of the form desired. We are now ready for the tin-foil and stippling. Take a strip

of No. 60 tin-foil, a little wider than the outside surface of the gum, and by commencing at one side with the broad end of the ivory-pointed carver, No. 3, burnish the tin down smoothly and uniformly over the entire surface, occasionally using the pointed end to work between the teeth, and the straight blade of carver No. 1 to cut the tin from around the teeth. The inside of the model is treated in the same way, except that a narrow, V-shaped piece is cut from the tin before placing it on the palatal

FIG. 37.



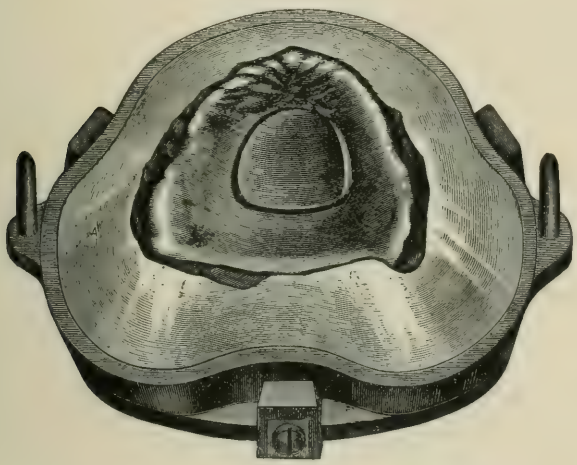
surface, to avoid folding, and that the entire outer edge of the plate is trimmed around. The stippling is done with an ordinary blunt-pointed excavator, or with a suitable engine plugger that will give a reacting blow. If done delicately and closely, the effect of the stippling is very pleasing."

Manner of Flasking.—The flasking or investing of the case should receive quite as much care as in rubber work. First mount the model high in the shallow half of the flask, especially designed for celluloid. Now pour in thin plaster until it just reaches the lower edge of the plate. When the plaster is set sufficiently, trim it to the proper shape for separating, and then coat it with the liquid soap. Place the deep ring of the flask in position and very carefully fill

with thin, well-mixed plaster. Place on the top, wash the outside of the flask to remove all the surplus plaster, then place it under gentle pressure for half an hour, or until the plaster has thoroughly set.

When ready to separate, place the flask in hot water for a few minutes,—the sections may then be readily separated; after this is done remove with a suitable instrument all the wax that is loose and easily detached, then pour a small

Fig. 38.

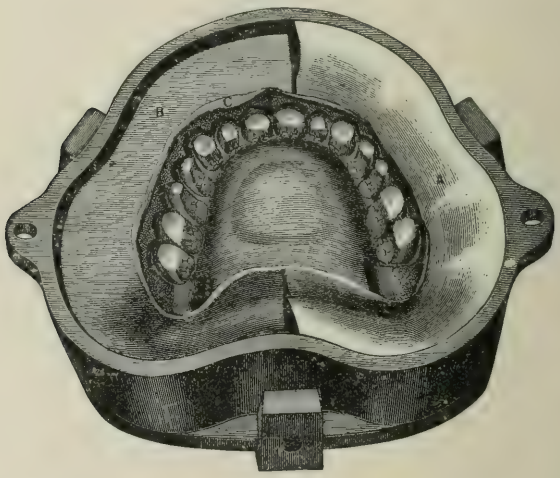


stream of boiling water upon the case until every particle of wax is washed out. Care should be taken at the same time not to disturb the tin-foil.

Outlet-grooves or Gates.—There are a number of methods of cutting vents or gates for surplus material, but the following, which is about as practiced by Dr. Evans, is probably the best. The upper half of the flask with piece invested is shown in Fig. 38. The wax has been washed out, exposing to view the roots of the teeth, platinum pins, etc., as ready to receive the base plate; the stippled tin-foil is clinging to the sides of the plaster, and the reverse

matrix, A, from the elevated portion, A, on the other half of flask. Fig. 39, B, indicates a portion of A cut away, illustrating the manner of forming vents; in this cut it is only carried half around in order show the condition before and after preparing. Commence by cutting a deep groove all around the piece close to the flask and gradually tapering up to the tin-foil or the margin of the plate, marked C. By this arrangement the material has free exit all around, yet

FIG. 39.



may not come out too rapidly. The plaster margins are not likely to be broken away under pressure, as the vent runs out almost at a right angle, thus leaving solid walls. Another advantage in this style of vent is that after the two halves of the flask have been pressed home the surplus material parts readily from the piece, leaving very little to dress up.

Selecting and Preparing the Celluloid Blank.—After the case is prepared as has been described, a suitable blank, one as near as possible the size and form of mold, should be

selected, allowing of course for some little surplus, and this should be as evenly distributed as possible.

The selected blank should be conformed as nearly as possible to the shape of mold by heating it in boiling water and pressing it with the fingers into the section containing the teeth; after which, if there is found to be more surplus than is necessary, it may be dressed away, either with a file, knife, or small saw, first softening the blank in boiling water before using them.

When plaster is used for the cast, it should be given a thin coat of oil, liquid soap, or liquid silex, or its surface should be rubbed with powdered soapstone or French chalk, to prevent the adhesion of the plaster to the plate. More perfect results, however, can be obtained by using a metal-faced model.

Molding.—Various heaters are used for molding celluloid into dental plates. There are machines designed to use glycerin or oil and others for steam or dry heat; and while with careful and intelligent manipulation satisfactory results may be obtained with all, some of them may possess special points of merit which the others do not. The limits of this work, however, will only permit of the introduction of one method, the one in most general use.

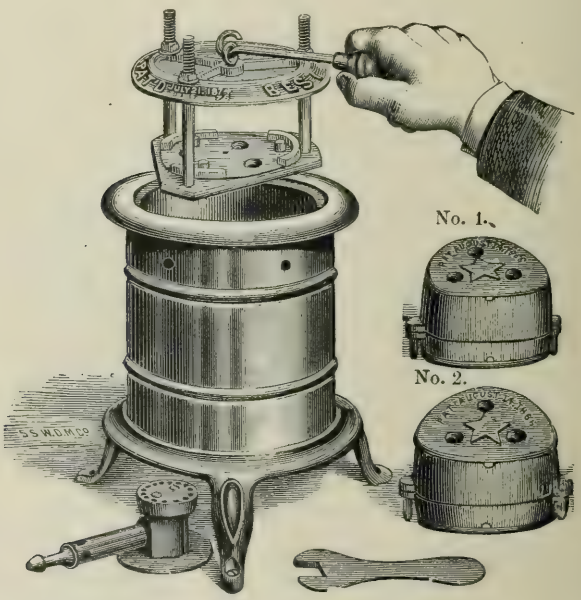
Hot Moist Air Machines.*—Richardson says of this method: In the use of these heaters, the water with which the plaster is impregnated is relied upon to produce the steam necessary to carry off all excess of camphor from the celluloid in the process of molding. An essential point by this method is to have the plaster in the flask thoroughly wet, and this may be better attained by setting the flask in a vessel of water before placing it in the heater. To provide against insufficiency of moisture in the plaster, a small

* So-called "Dry Heat."

quantity of water may be introduced into the tank before applying heat.

Fig. 40 represents a modeling or packing machine of the class here spoken of, and is designated as the "Best." The inside chamber is of cast iron, surrounded by a sheet-iron casing. The lid, of cast-iron, forming a part of the clamp, is pierced for the passage of three wrought-iron screw-bolts —the nuts being on the upper side and easy of access.

Fig. 40.



When these nuts are turned for the purpose of closing the clamp, the bottom portion of the clamp is drawn up by each revolution away from the flame, thus avoiding the danger of overheating the plate, and securing a uniform heat.

The bottom of the cast-iron chamber and the lid are pierced with holes to allow a circulation through the cham-

ber, for the purpose of carrying off the camphor which is set free in the process.

With the celluloid blank adjusted to its proper position in the flask, the latter is placed in the clamp and the top screwed down until it tightly presses the flask. It is then placed in the oven or tank, and heat applied.

If gas is used, the form of burner shown underneath the heater in Fig. 40, which gives a pure blue flame without smoke, may be used. If gas cannot be commanded, however, any of the alcohol or kerosene lamps commonly employed in vulcanizing may be substituted.

Having applied the heat, it is of the first importance that unremitting attention should be given to the process of molding until it is completed. If pressure is applied before the celluloid is rendered somewhat plastic, or too great force is exerted during the earlier stages of the process, and without sufficient intervals of rest, there is danger of crushing or fracturing the model and of impairing the articulation by displacement of the teeth. On the other hand, the nature of the celluloid is such that if it is exposed to a temperature of 270, without being under pressure, the camphor evaporates, and the material, besides being rendered hard and intractable, is puffed up, exactly as a loaf of bread is raised by yeast, and filled with air cells, and thus rendered porous.

Celluloid begins to soften at about 225, and will then yield slightly to pressure, but this should be applied very gently at first, with no more force than can be readily exerted with the thumb and finger. As the heat increases, and the celluloid becomes more and more plastic and yielding, the pressure should be correspondingly increased, but always interruptedly, giving the material time, between each turn of the screw or nuts, to escape from under the pressure. No considerable amount of pressure will be re-

quired in any case until near the close of the operation, when the mold is completely impacted, and the excess is being forced into the grooves or gateways as the flask comes together.

At this point considerable force will be necessary to close the flask perfectly, and somewhat longer intervals of time should occur between each turn of the screw or nuts.

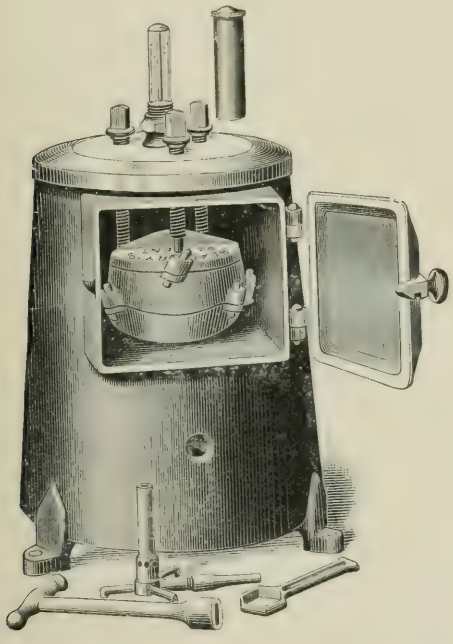
During the progress of the molding the flask should be withdrawn occasionally for inspection. If, in the case of central pressure, the flask is found to be closing unevenly, it should be loosened in the clamp and readjusted in such manner as to correct the faulty approximation. No difficulty will be experienced in this respect in the use of clamps provided with screw-bolts, as pressure may be applied at any point, and the flask be made to close uniformly without the necessity of shifting the latter.

The moment the flask is completely closed the heat should be turned off and the piece allowed to cool gradually. In no instance should the flask be removed from the clamp until it is entirely cold. In cases where the material is of extra thickness, or where the shape of the blank is totally altered, longer seasoning is advisable, and the flask should be placed near a stove or over a register (keeping it closed by a clamp) for half a day or more, at a temperature of not over 140°. If these directions are observed, no trouble from warping plates will be experienced.

Dry Heat Apparatus.—The Seabury Celluloid Press shown in Fig. 41. When the investment is thoroughly dried the flask is placed in the oven immediately under the screws as shown in the illustration. The screws are turned down until they bear lightly upon the top of the flask, after which the machine is closed and the heat applied. In five minutes time the celluloid will be sufficiently softened to permit the commencement of the molding. Close the flask

gradually, stopping occasionally if the resistance is very great. If the temperature is kept at 300°, the flask can usually be closed in about ten minutes. As soon as the flask is closed, the flame should be extinguished and the oven door opened to permit the case to cool.

Fig. 41.



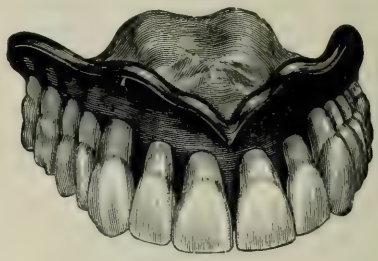
The Finishing Process.—After the flask has become perfectly cold the sections should be carefully separated by passing a knife-blade between them; a gentle movement will cause one or the other to leave the plaster, when the remaining one is easily detached by a few blows from the hammer on its edge. Now trim off the plaster from around the case, wash freely, cut away the surplus, and remove the tin-foil. The case is then ready for finishing, which is

accomplished with the use of the same instruments used in rubber work.

The final polish is given first with felt wheels and pumice stone, and afterward with brush-wheels and chalk, taking care not to use too much friction lest the plate should be warped.

Celluloid Combined With Other Bases.—The combination of celluloid with other dental bases, such as rubber, gold, and aluminum, is deserving, by reason of its merits, of favorable consideration. In commenting on this method Professor Charles J. Essig very justly remarks: "That we are able to produce an artificial denture embracing all that

FIG. 42.



is good in metallic and vulcanite work, at the same time avoiding the great defects of each."

The manipulation and details of constructing this class of dentures was first described by Dr. Hunt, of Indianapolis, Ind. It is as follows: Take the impression, make metallic dies, and form the plate as for work in the ordinary way. After fitting the plate in the mouth, get the articulation, the fulness and length of the teeth, remove the wax and plate from the mouth, and make the plaster articulation. In a full set, after separating the articulation, and before removing the wax from the plate, take a small, light pair of dividers, set them say one inch apart, and with one point following the margin of the wax representing the cutting

edge of the teeth, and the other point marking permanently the plaster, you have always in the dividers so set, a gauge for the length of any particular tooth. A convenient substitute for the dividers may be formed from a piece of wire of convenient length, one-half the diameter of a common excavator, by suitably twisting its middle for a handle, and its ends being sharpened, and pointing in the same direction, one or one and a half inches apart.

Thus far we proceed as we do for ordinary gold work. We will now suppose the teeth ground, leaving as much space between the teeth and plate as the plate will admit of. We next mark with a sharp-pointed instrument, on

FIG. 43.

the labial surface of the plate, each point where it is necessary to place a loop for purposes hereinafter described. Then apply wax to *external or labial* parts of the teeth and plate, in any manner sufficient to retain the teeth in position, remove the wax from the lingual parts of the teeth and plate, and mark the position on the metal and solder on loops or pins.

Pickle, dress, and polish that portion of the plate to be exposed to view. Bend and flatten the pins, arrange the teeth according to the articulation, waxing so as to cover up the loops if practicable; the loops should be placed as near the base of the teeth as possible, the celluloid forming, when finished, a part of that general concave shape which

is desirable in upper dentures, and which is not possible to obtain with the ordinary soldered work.* The case is now ready to be flasked, and should be treated as an ordinary celluloid denture to the finishing process. Figs. 42 and 43 suggest the appearance of the denture before and after the celluloid attachment is finished.

ARTIFICIAL DENTURES CONSTRUCTED BY THE SWAGING PROCESS.

Forming the Dies and Counter-Dies.—From the various methods which have been adopted, we will here consider only the one which has proven the most satisfactory and is most generally used. It consists in pouring melted metal into a mold, made in sand or marble dust, from a plaster cast. After the die is thus secured, the counter-die is obtained by pouring upon it metal which melts at a lower temperature than that of which the die is made.

Materials for Molding.—As we have stated, either sand or marble dust is usually employed for making molds. Marble dust absorbs sufficient moisture from the atmosphere to render it cohesive, which gives it the advantage of being always ready for use; it is also more cleanly to handle than sand, and gives a very smooth and uniform surface to the die. When sand is used it should be very fine, such as is used by brass founders.

It should be mixed with just sufficient water to render its particles thoroughly adherent. An excess of water should be avoided, as the vapor formed by the molten metal, when it is poured into the mold, will displace portions of the sand and form cavities or blisters upon the face of the die; nor

* For a full description of this method see Richardson's "Mechanical Dentistry," Seventh Edition.

should the sand be used too dry, as in that case it will crumble away in detaching the plaster model.

Oil is being used by some as a substitute for water in molding. Sand, when mixed with oil, has the advantage of always being in readiness for use. It should be used in about the proportion of one quart of oil to a peck of sand.

Preparing the Plaster Cast for Molding.—After the cast has been secured, the outline of the plate, and the position of the vacuum-chamber and clasps, when used, should be distinctly marked with a pencil. In upper cases, whether partial or full, a shallow groove should be made along the posterior plate line, so that when the plate is swaged this edge will press firmly against the roof of the mouth, which will add to the adhesion of the plate, make the edges less perceptible to the tongue, and prevent the entrance of the secretions and food. The cast should also be carved at the points where the integument of the palate is soft and yielding. In some cases, the center of the palatal portion of the mouth is unusually hard and unyielding, in fact, large, bony prominences are sometimes found; these points should be noted when the impression is taken; then, before making the die, a slight coating of wax should be placed over the corresponding parts of the cast, so as to relieve the pressure at this point, which pressure would otherwise cause rocking of the plate, thus interfering with its adhesion and the wearer's comfort.

Method of Making the Mold.—When the material has been selected and prepared, and the model trimmed and carved where needed, it should be given a coat of varnish or oil, or, what is still better, covered with lycopodium and then thoroughly brushed with a jeweler's brush or soft brush-wheel; it should then be placed face uppermost on the molding board or table, and surrounded with a metallic molding ring. The molding material should then be packed

closely and firmly around and over the cast until the ring is evenly filled. Considerable care should be observed in manipulating the molding material when packing. If it is too compact, the vapor formed in pouring the hot metal will not be able to pass out readily, and may cause imperfections in the face of the die; and, again, where it is too loosely packed the fluid metal will, to some extent, permeate the pores and render the face of the die rough and imperfect.

Level off the surface of the sand with a wooden rule, lift the flask or ring with its contents from the bench, turn it over carefully, and lay it down with the bottom of the cast up. Now run the point of a knife or spatula, held at an angle of about 40°, all round the cast, so as to make a bevel in the edge of the sand. Next press the sand around the cast firmly with the fingers, then brush away any loose particles that may remain, that none may fall into the mold when the cast is withdrawn. The point of an ordinary tack or pin, or the small blade of a knife, should now be carefully driven into the center of the cast by a few gentle taps from the hammer. Grasp the head of this firmly between the thumb and fingers, and with a small hammer distribute a few gentle taps over the surface of the cast. If the cast cannot then be withdrawn, continue the process, and at the same time give a few light blows to the edge of the molding ring, when it will usually be found that the cast can be readily lifted out.

All these manipulations must be very gentle, or the cast may be tilted or rocked in the sand, thus making a false impression.

Another method of removing the cast from the sand, practiced by many and as usually given in the text-books, is to re-invert the ring and contents, hold it above the table, and dislodge the cast by tapping it gently underneath. It is self-evident, however, that the former is the better method.

We should in nearly all cases reject a mold from which the cast had fallen out by its own weight.

The "Hawes" or Sectional Molding Flask.—It frequently happens that the case in hand presents such decided undercuts that it will be impossible to obtain a correct mold in the manner just described, as the sand would become impacted in these depressions and be broken away with the model when it is dislodged. This can be readily overcome by employing the sectional molding flask invented by Dr.

FIG. 44.

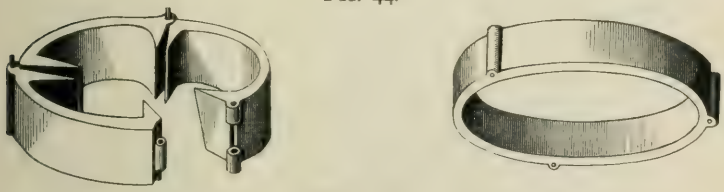
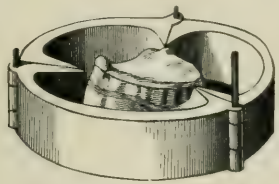


FIG. 45.

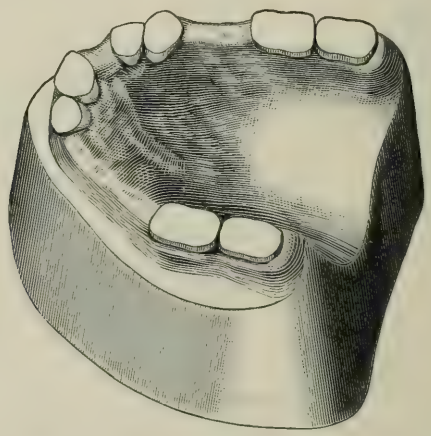


G. W. Hawes. It is composed of two sections or rings. The lower ring is composed of three movable pieces, with large extensions which project toward the center as represented in Fig. 44. When in use these pieces are kept in place by passing pins through the joints. The cast should now be placed inside of this ring; the portion representing the alveolar ridge should extend slightly above the top of the ring, as shown in Fig. 45. The sand should now be packed in around the cast to a level with the most prominent points on the outside of the ridge. The surface of the sand should be finished smoothly, descending slightly toward the

model, so as to form a thick edge of sand for the more perfect parting of the flask. Very finely pulverized charcoal should now be sifted over the exposed surface of the sand, to prevent the next portion contained in the upper section from adhering. The plain ring (Fig. 44) is then placed in position and filled with sand, which should be well packed over the face of the cast.

The upper ring is now carefully lifted from the lower one, which may then be parted by removing the long pin, when the cast should be taken away. The ring may be again

FIG. 46.



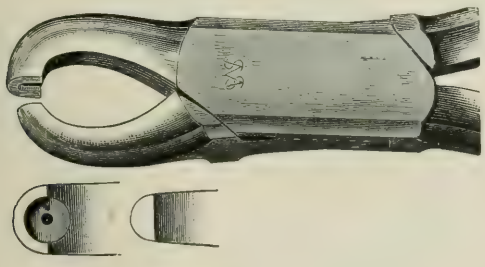
closed and fastened by replacing the pin; the upper section is then readjusted, and the entire flask inverted, when, if the process has been accurately conducted, the mold will be found perfect.

Forming Pattern for Plate.—Having determined upon the proper form and dimensions of the plate for any given case, its outlines should first be traced upon the model with a pencil; from this an exact pattern in lead- or tin-foil may be obtained; in partial cases the pattern may be sufficiently ample to partially overlap the cut extremities of the teeth,

which have been previously cut from the model, as shown in Fig. 46. The outlines of the pattern are then traced upon the plate of gold or other metal used for the base. The redundant portions of plate are then cut away with plate shears and forceps, and the edges trimmed smooth with a file. A very convenient and almost indispensable instrument for cutting away the plate in conformity with the palatal curvatures of the teeth is the plate forceps, exhibited in Fig. 47.

Swaging the Plates.—The plate cut to the proper form is now annealed, then placed upon the die, and if for a full upper denture, or in a partial where the plate is to extend over the alveolar ridge, it is brought as nearly as possible into adaptation with No. 1 of the "progressive counter-

FIG. 47.



dies."* To form this narrow counter die the sand must be built entirely over the ridge, allowing only the palatine portion of the die to be exposed. The swaging process is continued by using counter dies Nos. 2 and 3. The second, as will be noted in Fig. 49, extends just beyond the center of the ridge, to gradually start the plate over the ridge, while the third or final counter, Fig. 50, embraces the entire ridge in the usual manner. The two metallic pieces —that is, the die and counter-die—are brought forcibly

* First described by Prof. I. N. Broomell.

together with a few steady and well directed blows from a heavy hammer. Tilting of the die, resulting sometimes from a one-sided blow, may be obviated by placing a cone-shaped piece of cast-iron, brass, or zinc over the die, the base of the cone resting on the back of the die; by this expedient the force of the blow is equalized and concentrated

Fig. 48.

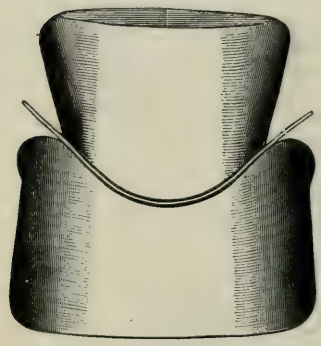


Fig. 49.

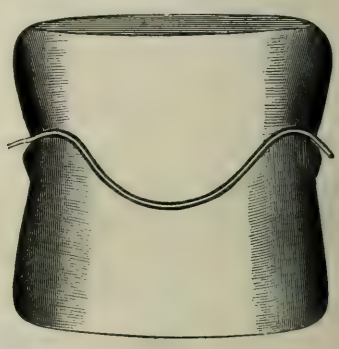
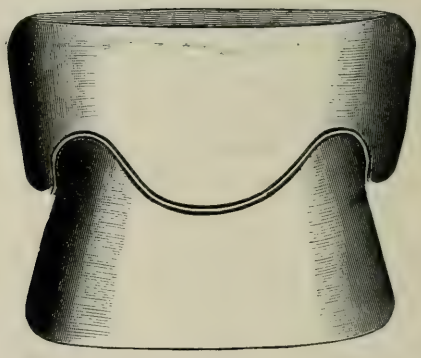


Fig. 50.

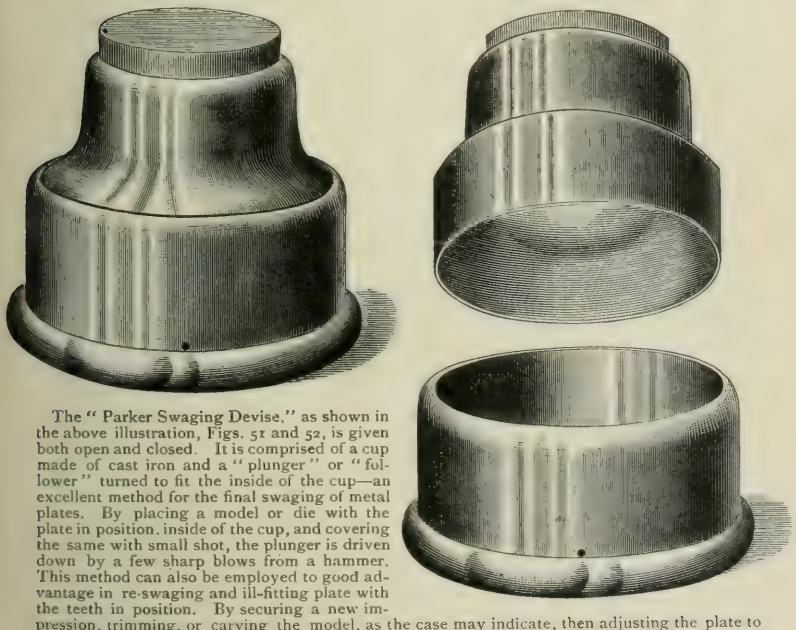


more directly over the die. If, in the process of stamping, any portion of the plate is found cracking or parting, its further extension at that point may be prevented by flowing a little solder, as near the crack of the plate as possible at the termination of the fissure.

Annealing the Plate.—During the progress of swaging, the plate should be frequently annealed, which is done by bringing it to a full red heat under the blow-pipe; the plate is thus rendered more pliant and can be more readily and perfectly forced into adaptation to the irregularities on the face of the die.

It is better in all cases to have duplicate copies both of the die and the No. 3 counter-die in reserve with which to com-

FIG. 51. FIG. 52.



The "Parker Swaging Devise," as shown in the above illustration, Figs. 51 and 52, is given both open and closed. It is comprised of a cup made of cast iron and a "plunger" or "follower" turned to fit the inside of the cup—an excellent method for the final swaging of metal plates. By placing a model or die with the plate in position, inside of the cup, and covering the same with small shot, the plunger is driven down by a few sharp blows from a hammer. This method can also be employed to good advantage in re-swaging and ill-fitting plate with the teeth in position. By securing a new impression, trimming, or carving the model, as the case may indicate, then adjusting the plate to the model and swage; the teeth being previously covered for protection, with the wax or plaster of paris.

SWAGING WITH SHOT.

plete the swaging, inasmuch as more or less deformity of both swages unavoidably occurs before the plate is brought into very accurate coaptation with the die. The stamping conducted thus far, the plate may be applied to the plaster model, and if found too full at any point, it should be

trimmed with the plate forceps and file to the exact dimensions required.

In partial cases, the margins of the plate adjoining the necks of the teeth should be permitted either to lie closely to them, or should be cut away, leaving a space equal to a line or more between the plate and the teeth; for if but a very narrow line of uncovered gum remains at these points, injury to the parts immediately surrounding the necks of the teeth is more liable to occur from strangulation of the interposed gum than if the plate were further removed from the teeth or rested directly against them.

If the portion of the plate which passes in between the remaining teeth is quite narrow, as where but a single tooth is to be supplied, it should be strengthened by doubling the plate at such a point. It is also advisable in many cases, in order to provide more perfectly against fracture or distortion of the base in mastication, to wire or double the entire border of the plate adjoining the necks of the teeth.

The edges of those parts of the plate occupying the vacancies on the ridge should be filed thin to admit of a more accurate adaptation of the artificial with the natural gum, and should not, ordinarily, extend beyond the outer circle of the adjoining teeth, allowing the gum extremity of the artificial tooth to overlap and rest directly on the natural gum above. If, however, the concavity between and above the teeth on the external border of the ridge is considerable, the interdentinal portions of the plate may overlap the border completely and underlie the porcelain gum or rubber, as the case may be.

Adjusting Clasps to the Plate.—Having proceeded thus far in the operation, the plate and clasps, when the latter are to be employed, should next be united to each other, and the utility and comfort of the appliance in the mouth, as well as the safety of the natural organs used for the purpose of support, will depend in a great measure upon the accu-

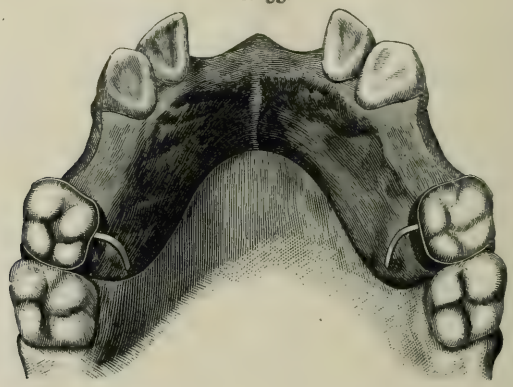
rateness of the relation of the several parts of the appliance to the organs of the mouth; it being a matter of primary importance that the various parts of the substitute should be so adjusted to the remaining teeth—especially those to which the clasps are applied—and the ridge and palate, that it shall not, in any material degree, act as a retractor upon the organs of support, or furnish interspaces for the lodgment of food, while at the same time it should be so fitted as to easily be removed and applied by the patient.

Manner of Securing Clasps to the Plate.—The clasps having been fitted to the plaster teeth and the base swaged to the form of the palatal arch and ridge, the clasps are adjusted to the teeth in the mouth, the plate is placed in its proper position, and an impression in plaster-of-Paris taken of the latter with all in place; plaster is recommended, as with it we can secure more accurately the relative adjustment of the several parts than with any other material. The impression, with the plate and clasp adhering, is then removed from the mouth, its surface oiled, and a model obtained in the ordinary manner. If, in separating the model and impression, the plate adheres to the latter, it should be detached and adjusted to the model and the clasps arranged upon the plaster teeth. The plate and clasps may now be attached to each other temporarily, with adhesive wax, in the relation they occupy on the model, and then removed carefully and the clasps and palatal face of the plate embedded in a mixture of nearly equal parts of plaster, sand, and asbestos. Before uniting the two pieces on the model with wax, however, the ends of the clasps should be slightly spread apart, in order that they may part readily from the plaster teeth, without, in any degree, changing their exact relation to the plate; in doing which, it should be observed that all parts of the clasps which are to be united to the plate should remain in close contact with the plaster teeth. After investment, in which the plate and clasps are embedded, has

become sufficiently hard, the portions of wax which temporarily united the latter should be removed, and the surfaces of the clasps and plate, where they unite with each other, coated with borax ground in water to the consistency of cream; small pieces of solder are then placed along the lines of contact, the investment heated in a furnace until the plate acquires full red heat, when it is removed, placed upon a suitable holder, and the solder fused with the blowpipe.

Another method consists in securing the proper relation of the clasps to the teeth in the mouth by the use, in the first instance, of what are termed " temporary fastenings." The plate and clasps are first applied as accurately as possible to the model, and are then connected by a narrow strip of plate or piece of wire bent in the form of a bow, the con-

FIG. 53.

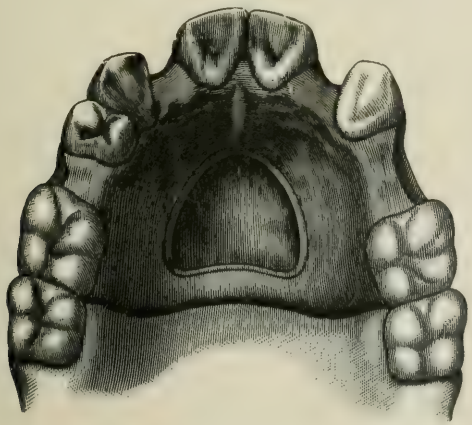


cavity facing the model, one end of which is lightly soldered to the palatal side of the clasp, and the other to a contiguous point upon the plate, as exhibited in Fig. 53, and the pieces thus temporarily united are removed from the model and adjusted to the parts in the mouth. If the position of the clasps is found in any respects faulty, they can be easily and

accurately adapted to the walls of the teeth by bending or twisting the connecting strip in any desired direction with pliers or other instruments suitable for the purpose. This accomplished, the plate and clasps are removed, and the operation of permanently uniting the clasps to the plate performed in the usual manner.*

Atmospheric Pressure or Adhesion as a Means of Support.—The method of attaching partial sets of teeth to the superior jaw by means of atmospheric pressure, or by adhesion, is more generally practiced than formerly, and wherever the condition of the soft parts of the mouth, the general configuration of the palatal arch, and the antagonism or occlusion of the artificial with the natural teeth favor its adoption, these forces, should, in all practical cases, be utilized in preference to the use of clasps for purposes of attachment.

FIG. 54.



The general form of the base, where several teeth scattered throughout the arch are required, is shown in Fig.

* For an elaboration upon this subject see Richardson's "Mechanical Dentistry," 7th Edition.

54. In most cases, whether one or a greater number of teeth are to be replaced, increased adherence and stability of the substitute will be better secured by permitting the plate to cover the larger portion of the roof of the mouth; though, in cases that present the best form of the vault, a diminished surface may be given to the base with equally satisfactory results.

Manner of Forming the Vacuum Chamber.—Where a central cavity, or "Air Chamber" is to be stamped into the base, the model should be prepared for the purpose before molding. Fig. 54 shows its general form and position. The model may be prepared in either of the following ways: 1. The form of the chamber may be cut from the wax or plaster impression, in which case the plaster will be raised at a corresponding point or points upon the model, and will have exactly the same form and depth as the cavity in the impression. 2. Cover the palatal face of the model with a sheet of wax equal in thickness to the required depth of the chamber, and cut out from this, at the desired point, the form of the cavity; fill the latter with plaster, and when hard remove the wax and trim the raised portion to the proper form. 3. Cut a pattern of the required form and depth of chamber from a sheet of wax or lead; place it in the proper position in the arch, and press it down with the fingers or burnisher until it conforms to the contour of the palate; it is then fixed in place either by confining it with a small pin or tack driven through it into the plaster, or by interposing softened wax or other adhesive material between the pattern and model.

The metallic swages being secured, the plate is placed between them and swaged until it conforms perfectly to the face of the die. During the operation the plate should be frequently annealed as has been previously described.

The Use of a Tracer.—Unless the plate used is purer and

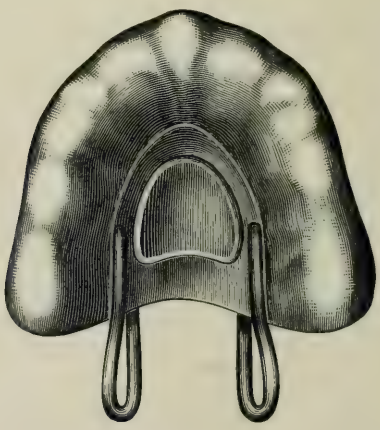
thinner than is generally employed, or than is consistent with the required strength, it will fail to be forced perfectly into the groove around the chamber by the process of swaging alone; a more definite border, however, may be formed by forcing the plate in at this place with a small, smooth-faced stamp or tracer, shaped to the angle of the groove, passing it round the chamber and with a small hammer carefully forcing the plate in until a somewhat sharp and abrupt angle is obtained to the palatal edge of the chamber. After the chamber is as perfectly formed as possible in this way, the plate should be well annealed and again swaged to correct any partial deformity occasioned by stamping the chamber.

The Soldered "Air Chamber."—A still more perfectly defined angle may be given to the borders of the chamber in the following manner: After swaging the plate sufficiently to indicate the exact position and form of the chamber, the portion forming the latter should be separated from the main plate by completely dividing it with a saw, or other instrument, cutting on a line with the groove around the chamber until the latter is entirely separated. The cut portion of the main plate is then trimmed evenly with a file and stones, being careful not to enlarge the opening more than is required to remove the irregularities of the edge formed in cutting. The plate, with its central portion removed, is then placed upon the die, when a separate piece of gold cut to the general form of a chamber, but somewhat larger than the opening in the main plate, is adjusted over the chamber, and struck up with the plate until the overlapping portions of the central piece are forced down upon the plate around the margins of the chamber. It is not, however, always necessary to employ a separate piece of gold for the chamber, as the central portion cut from the plate in the first instance may be sufficiently enlarged for

the purpose. This is accomplished by first flattening out the detached portion, annealing it, and then passing successive portions of its edges a sixteenth of an inch or more between the rollers, the latter being sufficiently approximated to produce a perceptible thinning of the margins. When the entire border of the chamber piece has been thus extended, it will be found so much enlarged that, when adjusted to the die and swaged in connection with the main plate, its borders will overlap and rest upon the margins of the opening in the base, as in the other case.

The portions of the plate and cut chamber lying in con-

Fig. 55.



tact are now temporarily secured in position by means of wire clasps as shown in Fig. 55, which, however, is illustrative of a full denture instead of a partial one. The edges of the chamber are now coated with borax and small pieces of solder placed along the line of union on the lingual side of the plate, when the two pieces, being transferred to the soldering block, are permanently united by flowing the solder with a blowpipe. Sufficient heat should be applied to induce an extension of the solder between the two portions

of plate, filling up completely the gap between them to the edge of the orifice in the main plate, forming, at this point, a square and well-defined angle to the margins of the chamber.

Having constructed the base to be used as a support for the artificial teeth, it is necessary, before arranging the teeth on the plate, to 1. Secure an accurate representation of all the antagonizing natural teeth. 2. If it is a partial denture, the plate should now be properly adjusted to the mouth, and an impression taken with it in position, bringing the plate away in the impression; into this a plaster cast should be run, which upon being separated from the impression will give an accurate representation of the remaining natural teeth, with the position of the plate and its relation to these teeth. 3. If there are enough teeth remaining that articulate with antagonizing teeth to act as an accurate guide, the two casts may now be adjusted and secured in an articulator. If, however, this cannot be done with any degree of accuracy, the plate should be removed from the cast, a rim of softened wax placed upon it at the several points where the teeth are missing. The plate with the wax attached is now placed in the mouth and the "bite" taken in the ordinary manner.* 4. If the case in hand should be a full denture, upper or lower, the articulation or bite is in every particular taken in the usual way, except that the swaged plate is used, instead of the temporary base plate, to support the wax rim.

Full Lower Base.—If the lower plate is constructed from a single lamina of gold or other metal, it should be somewhat thicker (about No. 24) than that used in upper cases, and should also be of finer quality, as the additional thickness of the plate and the peculiar form of the lower jaw render a greater degree of pliancy necessary in swaging it

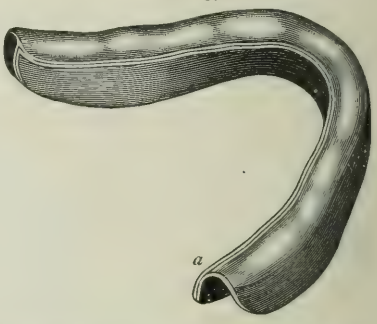
* See chapter on "Taking the Bite and Antagonizing the Models."

to the form of the ridge. The general form of a base for an entire lower denture is exhibited in Fig. 56. The inner or lingual border of this plate should usually be doubled, either by turning the edge over in swaging, or by soldering on a narrow strip of plate or half-round wire.

Reinforcing.—To secure a more perfect adaptation of the plate to the ridge, the use of a double instead of a single plate throughout, in which case a thin plate, No. 30 of the gauge, should be swaged to the form of the ridge in the

Fig. 56.

Fig. 57.

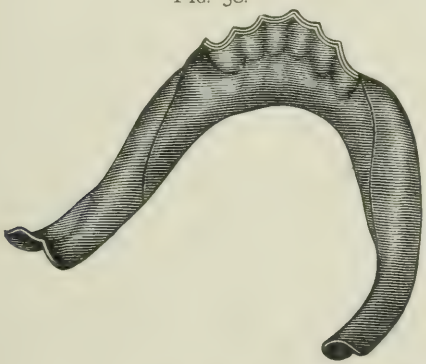


first instance, and then a duplicate plate, swaging the two together and uniting them to each other with solder. A plate of the specified thickness may be very readily and accurately swaged to any irregularities in the ridge, and when the two are united the base will be heavier and stronger than a single lamina of the ordinary thickness. Instead, however, of doubling the entire plate, it will be sufficient, in most cases, to adapt the second plate only to the lingual surface of the first, extending it up from the lower edge to a point corresponding as nearly as possible with the inner portions of the base of the teeth when the latter are adjusted to the plate. See Fig. 57. A moderately thin plate may, in this manner, be used for the primary base, while the duplicate band will impart the desired strength to the plate. In

adopting either of these methods the plates, after they are united to each other with solder, should be again swaged to correct any change of form which may take place during the soldering process.

Partial Lower Base.—To avoid encroaching upon the reflected portion of the mucous membrane, the glands beneath the tongue, or the frenum linguæ, it is necessary to make the lingual surface of the anterior portion of the palate quite narrow, which, of course, in partial cases, weakens the plate at this point. It is, therefore, desirable—even though the

Fig. 58.



ordinary thickness of metal has been used—to reinforce or double this connecting band, the duplicate piece extending back over the lateral wings of the plate, and crossing them obliquely as indicated in Fig. 58.

After this has been accomplished and the plate carefully fitted to the mouth, the "bite," antagonizing model, etc., are secured in the manner previously described.

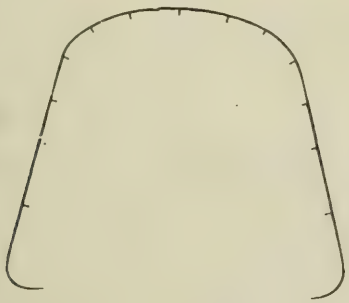
Grinding and Adjusting the Teeth.—In arranging or adjusting single gum teeth to the plate, the portions applied to the base should be ground away just sufficiently to restore the required fulness of the parts and to give proper length and inclination to the teeth. The coaptation of the ground

surface of the teeth to the plate should be as accurate as possible, so as to exclude particles of food, and to furnish such a basis to each tooth as will provide most effectually against fracture when acted upon by the forces applied to them in the mouth. The gum extremities of the teeth should also be accurately jointed, by grinding carefully from their proximate edges until the joints will be rendered incapable of ready detection in the mouth, care being taken that this coaptation of the adjoining surfaces is uniform, for if confined to the outer edge alone portions of the gum enamel may be broken away in the process of soldering. There are cases of a mixed character that render it more difficult to effect a harmonious and symmetrical arrangement of the teeth, as where a limited number of the natural teeth at intervals have been long absent, and the excavations in the ridge consequent on absorption alternate with other points upon the ridge in a comparatively unchanged condition. To give uniformity to the denture by restoring perfectly the required circle of the arch in such cases will necessitate the employment of plain and single gum teeth conjointly. Whenever necessary, those portions of the base occupied by the plate teeth may be cut away in such a manner as to permit the latter to be adjusted directly to the unabsorbed gum.

Arranging the Teeth for a Full Upper and Lower Denture.—In the process of grinding the teeth to the base, above and below, the operator should commence by first arranging the superior central incisors, and then pass back from tooth to tooth, grind and adjust, until the entire upper set is arranged. The superior central incisors should be placed parallel with each other, but *the cutting edges of the laterals and the points of the cuspids should incline slightly toward the median line of the mouth.* The anterior six may be made to describe, with more or less exactness, the segment

of a circle, but a somewhat abrupt angle may be given to the arch on each side by placing the first bicuspid within the circle in such a way that, when standing directly in front of the patient and looking into the mouth, only a narrow line of the exterior face of the crowns of these teeth will be seen, while the remaining teeth posterior to them should be arranged nearly on a straight line, diverging as they pass backward. When arranged in the manner described, the peripheral outline of the arch will exhibit some-

Fig. 59.



what the form presented in the accompanying diagram (Fig. 59).

The lower teeth should now be arranged, and to best accomplish this, *the bicuspids should first be adjusted,* then the teeth anterior to them may be secured in position, and lastly the molar teeth articulated. By first securing the proper occlusion with the bicuspids the anterior teeth can be arranged to suit the peculiarities of the anterior part of the jaw. In articulating the upper and lower teeth, the normal occlusion of the natural organs (which is described in another place) should be imitated as nearly as the other essential requirements of the case will admit.

In selecting teeth for a full upper denture in those cases where natural teeth are remaining below, or vice versa, the

color, size, and form of the latter will serve as a guide in the choice of teeth appropriate for the opposite jaw. In fitting and arranging the teeth upon the base, and in antagonizing them with the opposing natural teeth, the same general principles apply as those just described in connection with full upper and lower dentures.

Having adjusted the teeth to the base, they should be placed in the mouth before uniting them permanently to the plate, to detect and remedy any error of arrangement either in respect to prominence, position, inclination, length, or articulation.

Manner of Forming a Rim to a Plate.—If the case is one where single gum or block teeth are employed, and it is intended to form a socket or groove upon the borders of the plate for the reception of the plate extremities of the teeth, the rim forming the groove should be fitted and soldered to the base before investing the piece in plaster. If the alveolar ridge above is shallow, and but imperfectly concealed by the lip, a rim to the plate will be inadmissible; lest when the mouth is opened and the lip retracted, as in laughing, the metallic band will be exposed to view.

A rim may be fitted and attached to the base in the following manner: An impression in plaster is first taken of the gum surfaces of the teeth and exposed border of the plate; but as it will be impossible to detach the plaster in perfect condition when encircling the entire arch, or to swage perfectly with a die so unfavorably formed for stamping, separate impressions of the two lateral halves of the piece should be taken from these plaster models, and from the latter, dies and counter-dies; with these, two strips of plate of sufficient width are swaged, each extending from the heel of the plate to a little beyond the median line in front, overlapping slightly at the latter point. The portions of the swaged strips embracing the plate ends of

the teeth are then trimmed to the proper width, and scalloped, if desired, in correspondence with the festoons of the artificial gums. In whatever way the rim is formed, when it has been fitted to the plate and teeth it may be held temporarily in place with clamps adjusted at two or three points around the plate and then transferred to a soldering block, and secured by first tacking it at two or three points with solder. The groove may then be filled with whiting, mixed with water or alcohol, to prevent the solder from flowing in and filling it up; after which small pieces of solder are placed along the line of union next to the edge of the plate, and the rim permanently united throughout with the blowpipe; following which the wax and teeth are reapplied to the plate.*

Investing.—The plate, with the wax and teeth in place, is next invested preparatory to backing the teeth and uniting them with solder to the base. For this purpose, plaster and sand in equal parts may be employed. It is customary to incase the piece in the plaster mixture to the depth of from one-half to three-fourths of an inch, leaving only the lingual surface of the plate and teeth uncovered.

Backing the Teeth.—The plate being properly invested, all portions of the wax attached to the inner surface of the teeth and plate should be thoroughly removed with suitable instruments, after which backings are to be adjusted to the teeth.

A plain strip, corresponding in width with the tooth to be lined, is cut, and the end resting on the main plate conformed accurately with the file to the irregularities on the surface of the latter, and in such a manner as to permit the strip to take the direction of the tooth. The general form

* For a fuller description, see Richardson's Mechanical Dentistry, 7th Edition.

of the stay may, in the first place, be obtained by cutting a strip from a piece of gold with a pair of plate forceps. The points upon the stay to be pierced for the admission of the platinum pins may be ascertained by coating the surface of the former with wax softened in the flame of a spirit lamp, and pressing it first against the lower pin, the point of which will be indicated by an indentation of the wax. The backing is then perforated at this point with a plate punch. The strip is then reapplied to the upper pin, and the second hole obtained in like manner as the first. Instead of using wax, the ends of the rivets may be stained with some pigment, which will show the points to be pierced in the backing.

The backings should be adapted accurately to the back of the tooth; it is then cut to the proper length, reaching nearly or quite to the point, and shaped with a file to the general form of the crown. When the stays are to be united they should be formed with a shoulder at a point corresponding with the neck of the tooth, and the proximate edges below united closely. The process of soldering will be greatly facilitated and the piece will be more easily and artistically finished by securing, in the first instance, a perfect coaptation of all the parts which are ultimately to be united. The sides of the holes in the backings facing the plate should now be enlarged or countersunk with a spear-shaped or conical bur drill, and when applied to the teeth the projecting ends of the platinum pins are cut off even with the backings and then split and spread apart with a small chisel-shaped instrument. A head will thus be formed to the rivets, when solder is fused upon them, which will prevent them from drawing from the linings.

The Soldering Process.—All the lines of union between the several pieces should next be well scraped, exposing a clean, bright, metallic surface to the solder; the seams are

then coated with borax, ground, or rubbed in clean, soft water to about the consistency of cream;* after which small pieces of solder are placed along the joints and over the points of the platinum pins. The piece thus prepared is now placed in the furnace or ordinary fire-place in order to heat the entire mass preparatory to soldering.

The heating process should be conducted gradually until the case acquires a visible red heat, when it should be removed, placed on a suitable holder, and the solder fused with the blowpipe. A broad, spreading flame should first be thrown over the entire surface of the plate and investment until the temperature of the entire mass is nearly that required to fuse the solder, which is indicated by the latter settling and contracting upon itself; the flame may then be concentrated upon a particular point, as at the heel of the plate on one side, passing around from tooth to tooth until all the parts are completely united and the solder is well and uniformly diffused.

Having united the teeth to the plate, the piece may be allowed to cool gradually, or it may be plunged after the lapse of a few minutes into boiling water without risk of injury to the teeth. When cool, the plaster is removed and the plate placed in the acid bath (a solution of equal parts of sulphuric acid and water), where it may be allowed to remain until the discoloration of the plate and the remains of the vitrified borax, incident to the soldering, are removed, or it may be put into a small copper vessel, partly filled with the same solution, and boiled for a few minutes. After removing the plate from the acid, it should be boiled

* Slate is often used for this purpose, but is unfit, as, in rubbing the borax, loosened particles of the former become mixed with the latter and impede the flow of the solder, and becoming entangled render it unclean and porous. Ground glass or a porcelain slab is the best for the purpose.

for five minutes in a solution of chlorid of soda or common salt and water to remove all traces of the acid.

The Finishing Process.—Superfluous portions of solder are now to be removed, which may be more quickly accomplished by the use of burs, stones, and discs of various forms and sizes attached to the dental engine. The final polish may then be given by the use, first of crocus and then rouge applied upon a French felt wheel, rapidly revolved upon the lathe.

ARTIFICIAL DENTURES UPON A CAST METAL BASE.

The method of constructing artificial dentures upon a cast metal base has, until recently, had but a very limited application.

The method, as commonly practiced, is chiefly applied to lower dentures in cases where unusual absorption of the alveolar ridge has taken place, requiring increased weight to secure sufficient stability of the substitute. The alloys employed for this work are those originally compounded by Drs. Wood, Watt, and Weston, and are known upon the market by these respective names—as Wood's, Watt's, or Weston's Metal.

The manipulations concerned in this method are precisely the same as for rubber work up to the flasking process, except in forming the cast. As plaster-of-Paris alone will not give sufficient strength, either to the model or to the investment, it should in all cases be thoroughly mixed with an equal part of either marble-dust, silex, pumice-stone, or some other substance which will maintain its form perfectly under the heat necessarily applied in thorough drying and in casting the base.

Flasking.—Assuming that the teeth have been properly

articulated and waxed up, the case is now ready for the flask. One of the best adapted flasks for casting is shown in Fig. 60. The piece is flasked in the same manner as for rubber work, except that the investment material used should be the same as that employed for the cast. After the investment has become sufficiently hard, the sections of the flask are separated, grooves or gateways are cut from the posterior margins of the mold to the openings shown

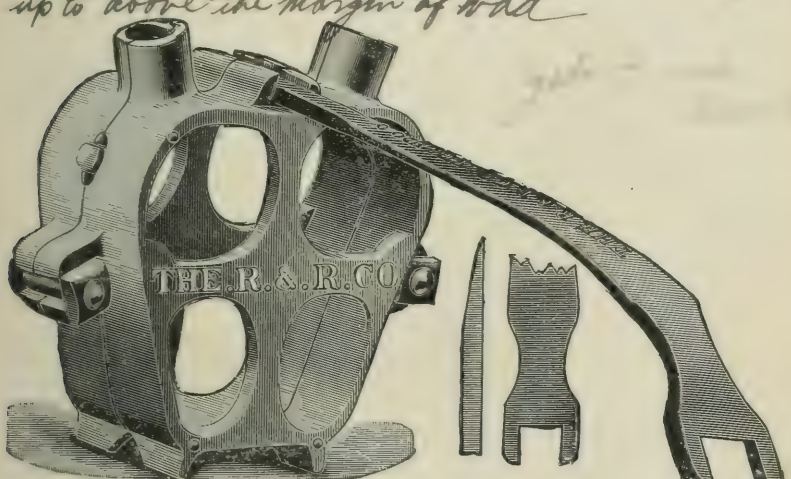


Fig. 66.

in the figure, thus providing for the pouring of the molten metal upon the one side and the escape of the surplus up the other; after which all traces of the wax should be removed with boiling water.

The mold is next well dried by exposing it to an oven heat for two or three hours; the sections of the flask are then adjusted to each other, and tightly clamped to prevent the escape of the metal when poured. Before bringing the alloy to the fusing point (which should always be done in a clean crucible), the mold should be tested for moisture.

This is done by holding the surface of a mirror over the openings in the flask; if there is a trace of moisture being driven off it will be shown upon the glass, and the heat should be continued until the case is completely dried, when it is ready for casting.

Pouring the Metal.—The metal should now be poured into the mold through one of the lateral openings, and it should rise quickly and freely into the opposite one. If bubbling should occur, which will never happen if the cast has been sufficiently dried, the flask should be lightly tapped on some hard surface until the ebullition ceases, thus insuring a more certain intrusion of the metal into all parts of the mold before solidification takes place.

The Finishing Process.—When the flask is quite cold, the plate may be readily removed by soaking the investing material for a moment in water. All superfluous metal is now removed with suitable scrapers, files, and sand-paper or emory cloth, and the final polish given with the brush-wheels, pumice-stone, and whiting.

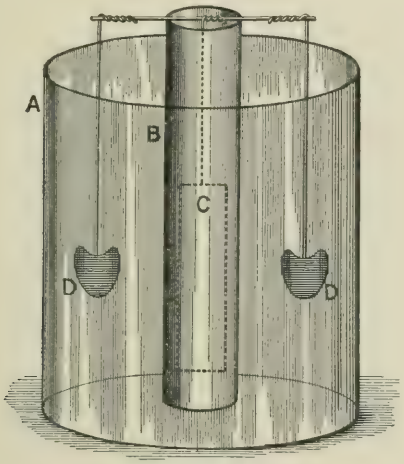
When it is desirable to make a pink rubber rim about the necks of the teeth, this portion of the wax should be carved out before flasking and pouring the metal. The wax can be carved away to any depth to suit the requirements of the case. The plaster will run in and fill this space in the flasking process, thus preventing metal from occupying it. After the metal is finished up, rubber may be packed about the teeth in the usual way and vulcanized.

ARTIFICIAL DENTURES UPON AN ELECTRO DEPOSITED BASE.

Deposition of Copper by the Single-Cell Process.—The simplest form of arrangement for the deposition of metals, either for artificial dentures or electrotyping small objects,

is known as the "single-cell" process. This form of battery is shown in Fig. 61. A indicates the outer jar; B, the porous cup or cell, which is somewhat taller than the containing vessel; C, the zinc (amalgamated), which is made from a strip of sheet-zinc, and is suspended by means of a copper wire; while D represents suspended plaster casts.

Fig. 61.



Preparation of Solutions.—Make a saturated solution of copper sulphate (blue-stone) by dissolving crystals of that substance in hot water. This should always be of sufficient strength to have a few of the crystals remain suspended. The solution, when cold, is poured into the outer jar. The solution used in the porous cup or cell is dilute sulphuric acid (sulphuric acid 1 part, water 10 parts), which should stand a little higher in the cell than that in the outer jar. This should be replenished about every 24 hours when in operation.

Amalgamating the Zinc.—Thoroughly cleanse the zinc by washing it in dilute sulphuric acid. This is best accom-

plished by placing the zinc in a dish, pouring a small quantity of acid over it, then, after having tied a small piece of flannel over the end of a stick, proceed to brush the acid over the surface of the metal; after which pour a little mercury on the plate, and, with a similar little mop, rub it thoroughly over and into the surface of the zinc, which will give it a bright, silvery luster.

Preparation of the Plaster Cast.—Have the cast well dried; twist around it a piece of copper wire, then dip in melted wax and allow to drain. The cast is then to be covered with finely powdered plumbago by briskly brushing it over the surface with a soft brush, care being taken to brush the powder well into every crevice.

The Deposition of the Metal.—The cast is now connected to the large copper wire which supports the zinc plate, and is gently lowered into the copper solution in the outer jar, when the whole arrangement is complete. The cast should remain in this position until the desired thickness of copper has been deposited.

THE DEPOSITION OF SILVER.

In silver plating the solutions are formed from silver nitrate. In preparing which, dissolve 1 oz. of fine silver in 2 ozs. of nitric acid and ½ oz. of distilled water.

Method of Preparing Silver Nitrate.—This is best accomplished by first placing the silver in an evaporating dish, then adding the water, and lastly the acid. A vigorous ebullition then takes place, giving off red fumes of nitrous gas, which are injurious and should be allowed to escape through the chimney or out the window.

After the action begins to quiet down a little, the dish should be placed upon a warm sand-bath. When the fumes cease to appear the chemical action is at an end.

It should now be set aside to cool, when, after a few hours, crystals of silver nitrate will have deposited, from which the remaining liquid is to be poured off. Another method is to evaporate to dryness, by which the free acid is all driven off.

Preparation of Silver Cyanid Solution.—Dissolve the prepared crystals of silver nitrate in three pints of distilled water, which should be effected in a glass dish, glazed earthenware, or stoneware vessel. Add to this solution a small quantity of common salt, a little at a time, until precipitation of silver chlorid ceases. Now pour off the clear solution and wash the chlorid of silver several times with distilled water.

A strong solution of potassium cyanid (about ½ a pound to 1 quart of water is usually employed) is now added to this white precipitate, a little at a time, when the silver cyanid will be formed. While the solution is being added it should be well stirred with a glass rod. In making up a quart of the solution, use the 1 ounce of fine silver, previously alluded to, with one-quarter of a pound of potassium cyanid, and a quart of distilled water.

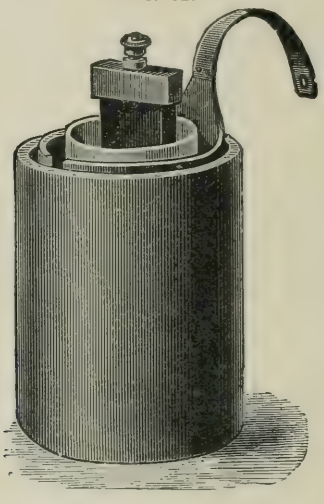
Silver Bronze for Plaster Cast.—In preparing silver bronze for the cast, place a small quantity of silver chlorid in a dish and add a few drops of sulphuric acid and a small piece of zinc. After all action has ceased, the silver bronze thus formed is thoroughly washed and dried.

Preparation of Plaster Cast.—A piece of copper wire is placed around the cast and the ends twisted until it is thoroughly secured. The cast is then immersed in melted wax, after which it is carefully and thoroughly coated with the silver bronze, which is best applied with the end of the finger.

Manner of Making Attachment to the Battery.—In this work Nos. 1, 2, or 3 Bunsen battery may be employed. To

the wire coming from the zinc of the battery, attach the ends of the wire encircling the cast, suspending the latter in the jar of silver cyanid solution. Then to the wire coming from the carbon to the silver solution attach a piece of fine silver, which is also suspended in the solution. The silver is called the anode and the cast the cathode.* These attachments

FIG. 62.



should remain for about 48 hours, the time required for a deposit of silver of sufficient thickness for an artificial denture.

The Bunsen Battery is composed of an outside glass or stone jar with dilute sulphuric acid (sulphuric acid 1 part to 10 of water). In this is placed a cylinder of stout sheet zinc, well amalgamated. A porous cup or cell is placed within the zinc, and in this a block of carbon is gently depos-

* The conductors immersed in the liquid to be decomposed are termed positive and negative *electrodes*. The positive electrode, or the conductor by which the current *enters* the liquid, is termed the *anode*, and that by which it *leaves*, or the negative, is termed the *cathode*.

ited (Fig. 62 represents this form of battery). The cup is then nearly filled with eight parts of a saturated solution of bichromate of potash to one part of sulphuric acid, when the arrangement is complete.

DEPOSITION OF GOLD.

Since for the deposition of gold it is necessary that the metal be brought to the state of solution, we will first consider the method of preparing the salt commonly known as the *chlorid of gold*, but which, strictly speaking, is the terchlorid, as it contains three equivalents of chlorin.

Preparation of Gold Chlorid.—The most convenient way to dissolve gold is to place the desired quantity in an evaporating dish and add to it a sufficient amount of *aqua regia* (2 parts hydrochloric acid and 1 part nitric acid) to dissolve it. To dissolve 1 ounce of gold (troy weight) about 4 ounces of aqua regia is required.

The chemical action which takes place may be accelerated by placing the dish upon a moderately heated sand-bath. Heat should then be gently applied to drive off the acid, until the mass assumes a dark-red color and just ceases to flow about the vessel, at which moment it should be set aside and allowed to cool.*

The red mass, or the gold chlorid, is next dissolved in distilled water, which will assume a clear, brownish-yellow color. If after the chlorid is deposited a white deposit remains in the bottom of the dish, it is the chlorid of silver, resulting from a trace of that metal having been present in the gold.

* If too much heat is applied when the solution has acquired the dark-red color, it will quickly become reduced to the metallic state. It would then become necessary, after dissolving out the chlorid with distilled water, to test it with aqua regia, which will redissolve it.

Ammonium Gold Cyanid Solution.—To the solution of gold chlorid, aqua ammonia is added, a little at a time with stirring, until all the gold is thrown down in the form of a brown precipitate. The liquid is poured off and the precipitate or ammonia gold is washed several times with distilled water. It is now dissolved in a strong solution of potassium cyanid, which is then filtered.

Gold Bronze.—Take a solution of gold chlorid and precipitate with a solution of iron sulphate; wash thoroughly and dry. This is then used as the gold bronze for coating the cast, before attaching it to the battery.

Preparation of the Cast.—The cast, as directed for silver and copper work, is encircled and well secured by a piece of copper wire. It is then coated with gold bronze, and attached to the negative wire of the battery ready for action.

Deposition of the Metal.—The Bunsen battery is employed. A piece of fine gold is soldered to a small platinum wire, which is attached to the copper wire coming from the carbon of the battery, as the anode; the cast being attached to the wire coming from the zinc, which acts as the cathode. These are gently lowered and left suspended in the vessel containing the ammonia gold cyanid solution. If this solution is worked cold it requires about five days to deposit a sufficient thickness of gold for an artificial denture. If, however, it is kept at about 130° F. the result may be accomplished much quicker.

After the base plate is thus secured, the teeth are secured by means of rubber or celluloid attachments. See chapter upon the subject.

ARTIFICIAL DENTURES FORMED BY THE "CONTINUOUS-GUM" PROCESS.

Preliminary Process.—The manipulations connected with the formation of the plaster model and metallic swages are essentially the same as in the construction of ordinary gold work. The plate, or base, is formed of pure platinum plate, 29 gauge for the upper and 26 for lower. This being properly swaged, and accurately fitted to the mouth, the outer edge is reinforced by soldering around it a small flattened wire (22 gauge). This strengthens the plate and gives a good, round finish to the edge, as well as protects the edge of the porcelain. Pure gold should always be used for the soldering, and just enough borax to direct its flow.

The back edge of the plate should be doubled, that is, an extra piece of platinum should be swaged and soldered across it. This imparts increased strength, leaves some margin for slight change in case of necessity after the plate is in the mouth, admits of a neater finish, and protects the edge of the porcelain. This "doubler" should be about three-sixteenths of an inch wide, and the inner edge should be turned up slightly, before soldering, so as to better receive the edge of the porcelain. This turned-up edge should unite nicely with the ends of the wire around the tuberosities so as to give a perfect finish and protect the edge of the porcelain at every point.

The bite is next secured in the usual way, and the teeth arranged and secured with hard wax, with special reference to the requirements of the case. They are then covered with a thin coating of plaster-of-Paris mixed with water to the consistency of cream. Allow this to set firmly, then place round on the outside of the previous covering a somewhat thicker mixture of plaster and asbestos (one part of

the latter to two of the former), with water. This investment is brought up over the teeth with a spatula, so as to protect them from the flame in the soldering process.

Attaching the Teeth.—When the investment has become sufficiently dry and hard, the wax is removed, and boiling water dashed freely over the exposed portion of the plate and pins of the teeth, so as to thoroughly cleanse them for soldering. A rim or strip of platinum is now fitted to the plate and palatine surface of the teeth, below the pins. This imparts additional strength to the teeth.

The pins of the teeth, which do not already touch the plate (continuous-gum teeth having unusually long pins for this purpose) should be bent down over this rim and on to the plate. When it so happens that a pin will not touch, a small piece of platinum scrap is folded beneath, so as to make the connection complete.

With a small brush place borax on the pins and plate at the points touching, and along the edge between the rim and plate. Small pieces of pure gold are now placed at all these points of union. It is all now slowly introduced into a heated muffle, and brought gently up to a red heat; then withdrawn from the furnace and placed quickly under the blowpipe to flow the gold.

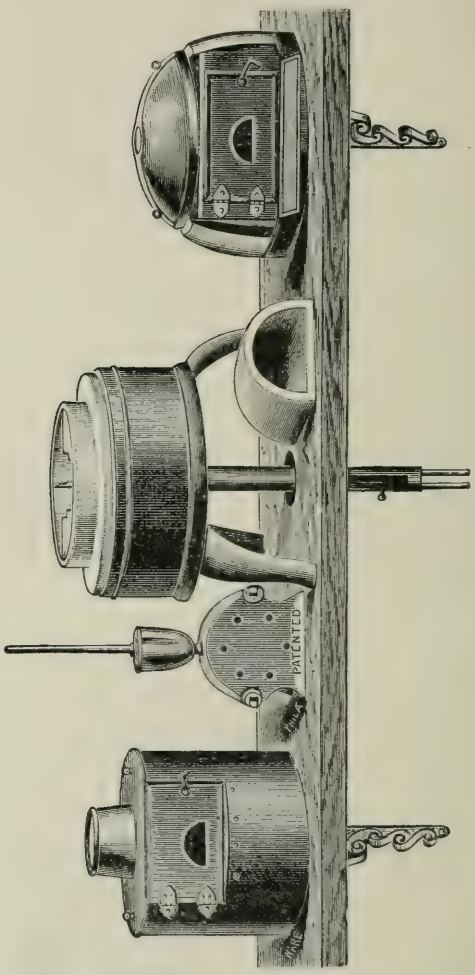
After the case is thoroughly soldered and cooled, the investment is removed from the teeth, taking care to preserve the base portion for the plate to sit upon during the subsequent bakings of the body and enamel. The case should now, after being thoroughly cleansed, be tried in the mouth, and if any changes have taken place they should be corrected at this time. Everything being correct, the body can be applied.

Preparing and Applying the Body.—The body, which is supplied by dental dealers for this purpose, may be mixed with water in a small porcelain dish to the consistency of

cream; this is then applied in the plastic state and is distributed the desired thickness over the surface of the plate and around the necks of the teeth, a spatula or other small instrument being used for the purpose. After the body is on, tap the plate occasionally to bring the moisture to the surface, which should be absorbed with a soft clean napkin. The body should then be carved with small instruments and brush to represent the gum, giving the desired fulness, contour, etc., and the roof and rugæ of the mouth should be reproduced, taking care to keep the crowns and necks of the teeth clean and well defined. Small, clean cuts with a small knife blade should then be made, one between each of the teeth. Commencing with the space between the molars, the cuts should be made through the body to the rims and the plate, and should be both external and internal. The object of this is to prevent movement of any of the teeth from contraction of the body during baking, compelling the material to shrink toward the teeth, leaving smooth and irregular openings where the incisions were made, into which more of the body is packed and baked.

First Baking.—The plate should now be replaced upon the base of investment material, upon which it was soldered, and placed in the upper muffle of the heating furnace. The Sharp furnace is one of the latest and most approved appliances for this work; it is illustrated both in sections and complete in Figs. 63, 64. After the case has been placed in the upper muffle, heat may be applied, slowly at first, but gradually increased as the case is dried, until the muffle is red hot, when it is removed to the lower muffle in the furnace, which by this time will be almost to a white heat. Only a few minutes in this muffle is necessary to bake or biscuit it. Continue to raise the temperature until the body presents shining crystals, when the heat may be turned off entirely and the case withdrawn and placed in the upper

FIG. 63.

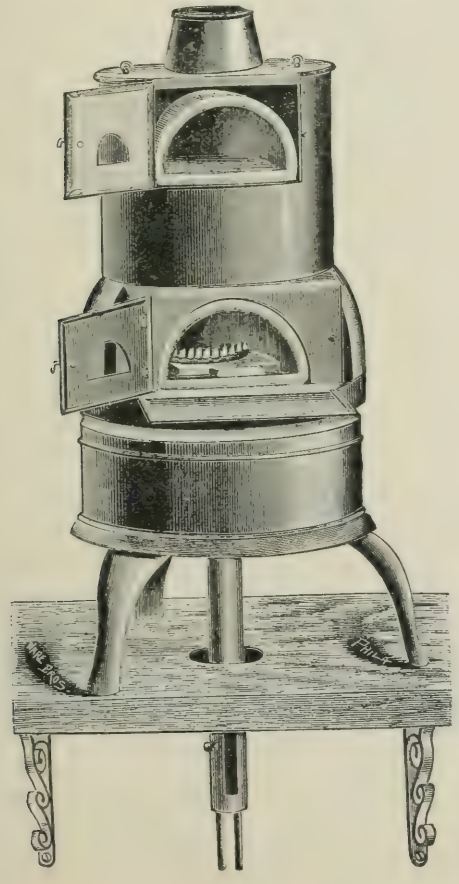


muffle. The whole top in which it is encased can be set off, thereby cooling the piece with perfect safety in a much less time than if allowed to remain in the muffle in which it was baked. As soon as cold, replace and adjust to the

die. The appearance of the case after the first baking is shown in Fig. 65.

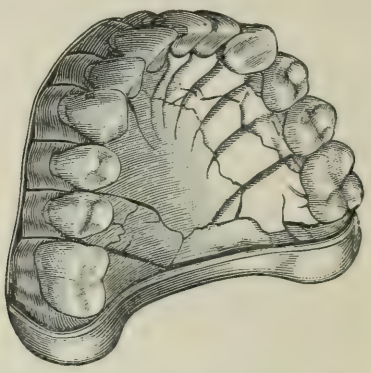
Final Baking.—The incisions and cracks in the body should now be packed carefully and perfectly with body; this should be jarred occasionally and the moisture well absorbed from the surface. Over this, a thin and even coating of enamel is applied, spatula and brush being used

Fig. 64.



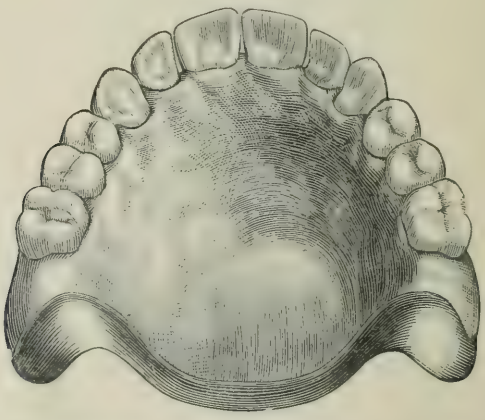
for the purpose, care being taken not to allow any enamel to remain on the teeth, and to pack it very nicely around

FIG. 65.



the necks. Now carefully tap the plate with the spatula to bring the moisture to the surface, which absorb with the napkin; then dry and bake the case again, bringing it to a

FIG. 66.



little higher temperature, so that more of the shining crystals will be seen. Cool down as before, and examine carefully for small cracks; if any should be found, fill them with

enamel, and refire. The plate when done will present a glassy or watery appearance. The gas must then be turned off, and the case allowed to cool in the cooling muffle. Fig. 66 illustrates the finished denture.

METALLIC BASE WITH RUBBER OR CELLULOID ATTACHMENT.

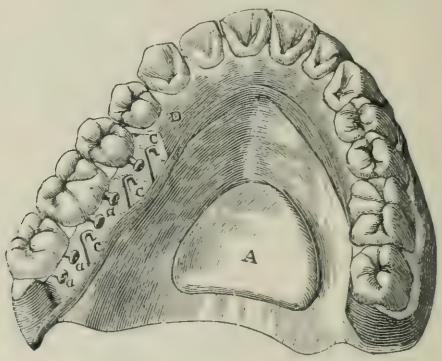
The method of attaching porcelain teeth to a metallic plate by means of rubber or celluloid has, in full dentures, many advantages over the soldering process. In point of cleanliness and purity it is much superior; the diminished liability to fracture of the teeth on account of the pliable nature of the attaching material used, the facility with which injury may be repaired, the practicability of remodeling the piece without impairment of the teeth or plate, are among the qualities which commend this form of denture.

In mounting teeth by this method, any of the metals employed for artificial dentures, whether gold, silver, platinum, aluminum, cast metal, or that formed by the electro-deposit process may be used. When a silver base is used it should be made from refined silver alloyed with platinum, with the additional precaution of interposing a layer of tin-foil in packing the case between the rubber and plate; this, however, is not necessary when celluloid is used.

Method of Procedure.—After securing the metallic base and fitting it to the mouth, the "bite" should be secured in the usual way and the plaster cast with the metal plate in position should be secured in an articulator. We now proceed as for ordinary gold work, the teeth are ground and jointed (if block or gum teeth are used), and held temporarily in position with a little wax upon the labial surface. Next mark with a sharp-pointed instrument on the palatine surface of the plate each point where it is desirable to solder

a pin or loop, which should be as near the base of the teeth as possible, then remove the teeth and wax. Now solder at the points indicated either short platinum pins or loops formed of small platinum wire or strips of plate, soldering, of course, with a lower carat than that used in the plate; bend or flatten the loops as desired; clean plate thoroughly in the acid bath, and polish that portion to be exposed to view. Return the plate to the cast and see that it fits accurately; rearrange the teeth according to the articulation;

Fig. 67.



wax up so as to entirely cover the pins or loops,—in fact, the pins should be so placed that when the palatine surface of the rubber is properly shaped they will not be exposed in the least. The case is now ready to be flasked, vulcanized, and finished up as usual. The principle is illustrated in Fig. 67.

Another method of increasing the attachment between the metallic base and the rubber, is that of spurring the plate over the ridge with a sharp-pointed chisel, as shown in Fig. 68.

When aluminum is employed as the base, the strongest and altogether the best means of increasing the attachment is that of cutting or punching loops from the plate itself.

Fig. 68.

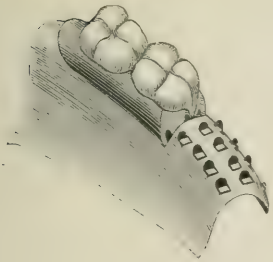


Fig. 69.

Fig. 70.

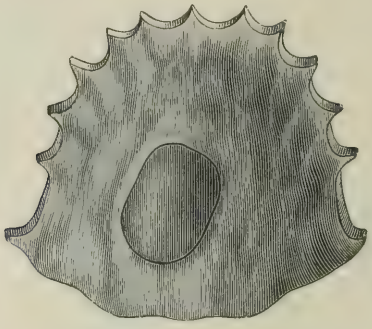
An excellent instrument for this purpose is that devised by Dr. J. H. Gaskill, which is illustrated in Fig. 69. The form of loop or attachment given by this instrument is shown in Fig. 70.

When a cast metal plate is employed, loops or pins are not needed, as sufficient anchorage is secured by cutting out the wax on the labial surface and from between the teeth (in fact, from every point where it is desirable to have the rubber) *before flasking for the casting process.* After the plate has been cast and finished, the rubber may be packed and the case re-flasked, vulcanized, and finished in the usual manner.

OBTURATORS AND ARTIFICIAL VELUM.

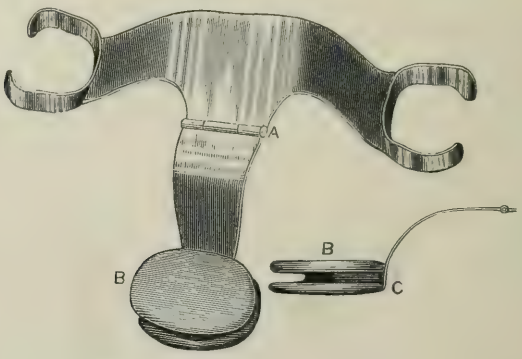
Palatine defects are divided into two classes, accidental and congenital. The first includes all loss of substance in either hard or soft palate by disease or accident after birth.

FIG. 71.



The second class includes all malformations of the palatine organs, from the simple division of the uvula to an opening through the entire palatine and maxillary bones, which may exist at birth.

FIG. 72.



Obturator.—The term obturator, properly speaking, is employed for all appliances intended to stop a passage in the

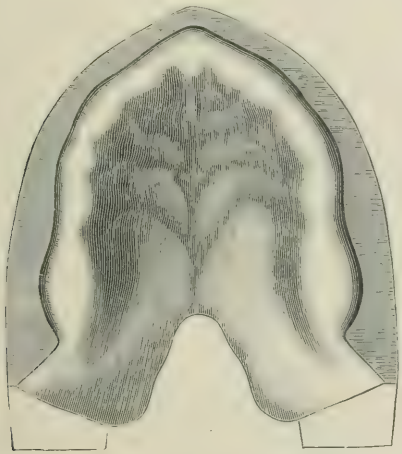
hard or soft palate which may have a complete and well-defined boundary.

Artificial Velum is the term for all appliances made to supply the loss of the posterior soft palate.

The different forms of appliances in general use are known as Kingley's, Suerson's and Baker's.

Kingsley's Methods.—A simple obturator for hard palate, without teeth or clasps, is represented in Fig. 71 and is intended for a perforation of the hard palate, being sus-

FIG. 73.



tained *in situ* by impinging slightly upon the natural teeth with which it comes in contact.

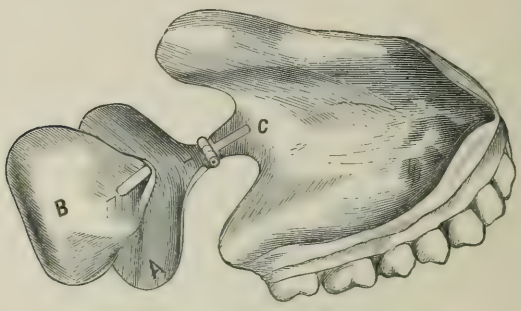
As Dr. Kingsley says of this, accuracy of adaptation and delicacy in form are all that is essential in such cases, and the restoration of speech will follow.

Obturator for Soft Palate.—The construction of an obturator for the soft palate is much more complicated. Quoting Dr. Kingsley, the necessity for a variation in the plan will be found in the anatomical fact of the constant muscular

action of the soft palate, which would not permit, without irritation, the presence of an immovable fixture.

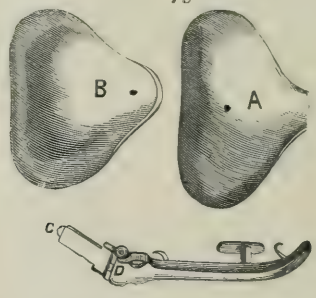
This is contrived with a joint that will permit the part attached to the teeth to remain stationary, while the obtu-

Fig. 74.



rator proper is carried up or down as moved by the muscles (see Fig. 72). The joint, A, should occupy the position of the junction of the hard and soft palates. The joint and principal part of the appliance is made of gold, the obturator of vulcanite. The projection, B, lies like a flange upon the superior surface of the palate and sustains it; otherwise

Fig. 75.



the mobility of the joint would allow it to drop out of the opening. This flange is better seen in the side view marked C. It is readily placed in position by entering the obturator first, and then carrying the clasps to the teeth.

Artificial Palates. The following case (Fig. 73) presents some unusual difficulties in not having any teeth to aid in supporting the appliance, making it necessary to adopt a plate which should not only sustain the teeth for

FIG. 76.

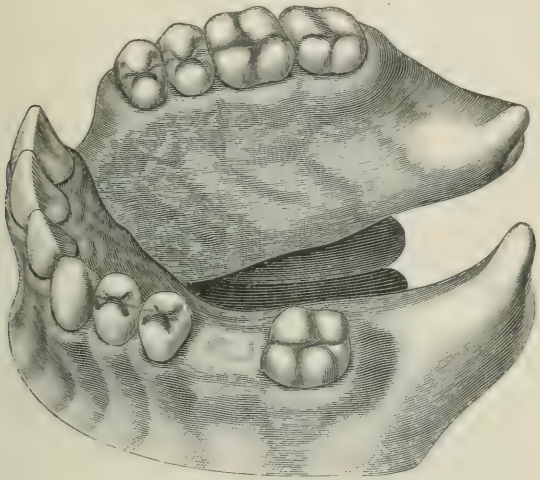
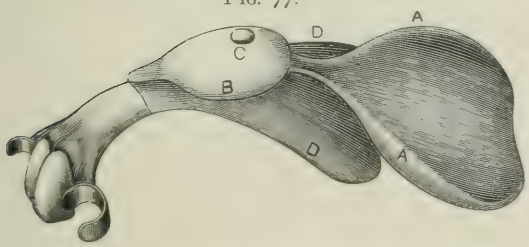


FIG. 77.



mastication, but bear the additional responsibility of supporting the artificial palate.

Fig. 74 illustrates the appliance as prepared for the mouth. The plate was made of gold and formed as is usual, except at the median line on the posterior border (marked c), where a groove was located to receive the attachment for the artificial palate. The wings marked A

and B are made of soft rubber; the frame to support them is made of gold, with a joint to provide for the perpendicular motion of the natural palate, as in the case of the obturator represented in Fig. 72.

Fig. 75 represents the artificial palate separated into its several parts. Letter C shows the tongue, which enters the groove in the plate and connects them.

Artificial Palates for Congenital Fissure.—To further illustrate Dr. Kingley's methods, the following case is presented.

FIG. 78.

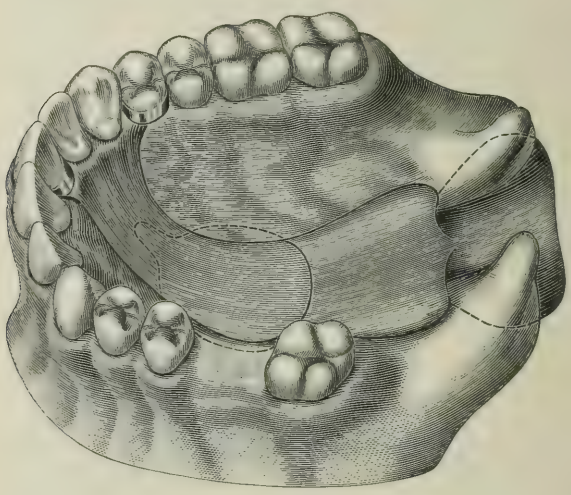
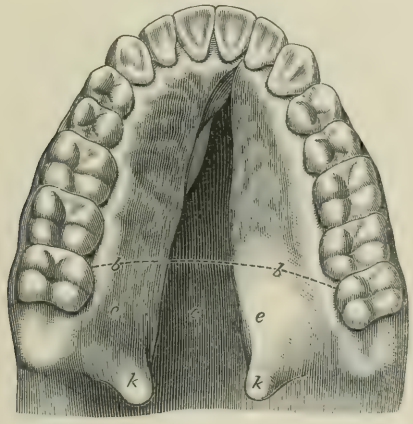


Fig. 76 represents a model of a fissured palate, complicated with hare-lip on the left side of the mesial line. There is a division, also, of the maxilla and the alveolar process, the sides being covered with mucous membrane, which come in contact with each other but are not united. The left lateral incisor and left cuspid tooth are not developed.

Fig. 77 represents the artificial velum, as viewed from its superior surface, together with the attachment and two artificial teeth to fill the vacancy.

The lettered portion of this appliance is made of soft vulcanized rubber; its attachment to the teeth of hard vulcanized rubber, to which the velum is connected by a stout gold pin firmly embedded at one end in the hard rubber plate. The other end has a head, marked c, which, being considerably larger than the pin, and also the corresponding hole in the velum, it is forced through, the elasticity of the

Fig. 79.

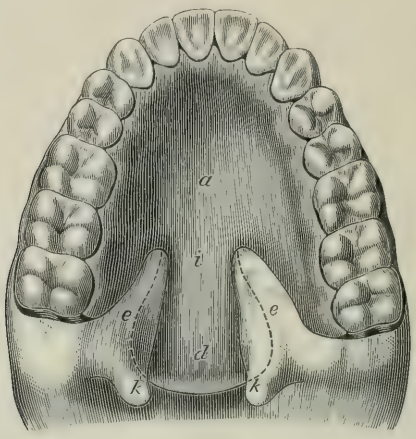


velum permitting, and the two are securely connected. Fig. 78 represents the appliance *in situ*.

Dr. Suersen's Method.—The principles of the appliance introduced by Dr. Wilhelm Suersen, of Berlin, has seemed to many to be the best for obtaining correct articulation. An ordinary plate is constructed, suitably attached to the existing teeth and covering any fissure that may exist in the hard palate. From the posterior border of this plate, in the center of the fissure, a hard and stationary bulb, which may be either hollow or solid and which will form the artificial palate, or velum, is attached. This method is illustrated in the accompanying illustrations, Figs. 79, 80, and 81.

As will be seen, Fig. 79 represents the mouth without the apparatus; Fig. 80 shows it in position; Fig. 81 gives a view of the appliance itself.

Fig. 80.



The simplest manner of constructing the bulb is to leave a small projection of rubber in the center of the posterior border of the plate; then, after vulcanizing and fitting the

Fig. 81.

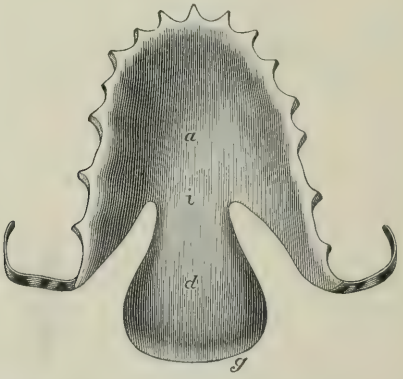


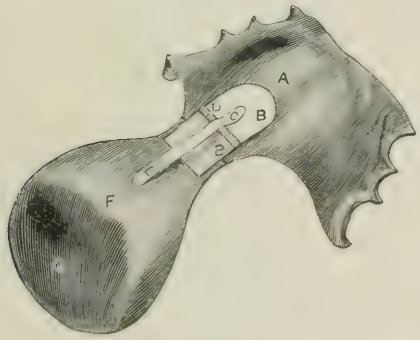
plate accurately to the mouth, build up upon this projection a bulb composed of modeling composition; construct this,

as near as possible, to fit the fissure in the soft palate, carry plate and bulb to position in the mouth; note any changes that need to be made in the shape of the latter; remove and trim away until the desired shape and adaptation is secured. The case is then ready to be flasked, packed, and vulcanized.

The plate, as will be seen in Figs. 79 and 80, covers the entire hard palate, from its boundary, marked *b*, to the beginning of the defect, and also serves to support the thick obturator, *d*. The simple plate portion is marked *a*.

The obturator, or bulbous portion, is so shaped that when in place in the pharyngopalatine space, the lower part, or that surface next the mouth, is about on the same level as

FIG. 82.

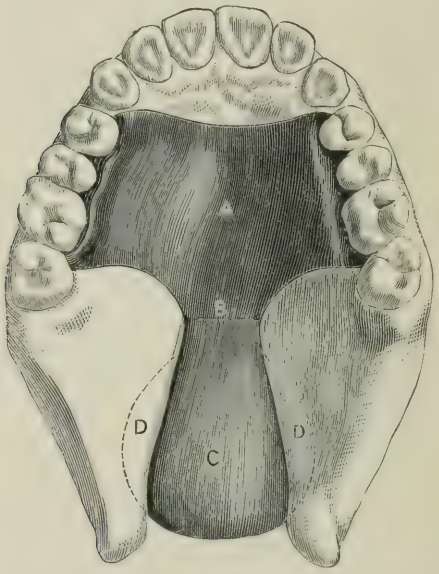


the rest of the velum palati. This will be noted at *d* and *e* in Fig. 80. The thickness of the obturator begins where the fissure of the soft palate begins, and it will be noted that the fissure velum palati, *c*, is in constant contact with the sides of the obturator. The fissured uvula is indicated at *K*.

When the walls of the pharynx are contracted by the action of the superior constrictor of the pharynx they are brought in contact with the obturator so as to temporarily close the space. But when these muscles are not in activity the obturator does not touch the pharyngeal wall.

Dr. Baker's Method. —The appliance known as the Baker velum is illustrated in Fig. 82. It consists of a gold or hard rubber plate covering the roof of the mouth down to the junction of the hard and soft palates. From this point the movable portion, F, extends back and downward, restoring symmetry of the palatal surface by bridging across and lying upon the muscles of each side. The spring, CE,

Fig. 83.



controls the upward movement of the bulb, F, the distal surface of which, G, is quite broad, and so constructed as to articulate with the pharyngeal wall, while the constrictor muscle contracts and closes around it on a semicircle. This is the Suersen principle, with the addition of the spring attachment, to further facilitate the acquirement of correct articulation. The Baker appliance in position is shown in Fig. 83.

INTERDENTAL SPLINTS.

Interdental splints are appliances used in the treatment of fractured jaws. They are usually constructed of vulcanite rubber, and are divided into double and single splints. The double splint, being the one usually employed, will be described in this place.

Taking the Impression.—The impression of both jaws should be taken, either in wax or modeling compound, using as small a quantity as will insure a good impression of the teeth and gums.

As it is impossible to keep the fragments of a fractured inferior jaw in perfect apposition while taking an impression, *no attempt should be made to entirely reduce the fracture at this time.* The sections, however, should be brought as nearly to position as possible without causing much pain to the patient.

An assistant should stand behind the patient and support the broken jaw, keeping it steady while the impression is being taken. This being more important when the fracture is double.

The impression material being ready, it should be introduced into the mouth and carefully brought to position. Much care should be exercised to prevent the pieces of bone and loosened teeth from moving when this material is being molded about their necks.

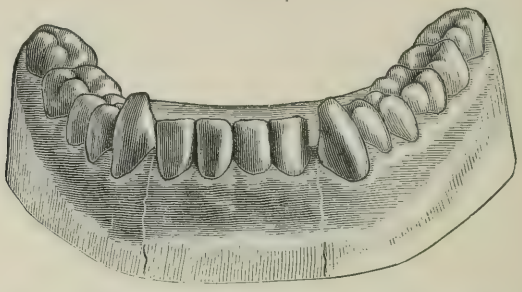
Preparing the Models.—After the impression has been secured, mix plaster and pour cast in the usual manner. Fig. 82 represents a cast showing a double fracture.

The casts or models of both jaws being obtained, they should be carefully articulated. This is done by cutting (with a small saw) the lower cast at the point or points of fracture, and rearranging the sections thus made so as

to bring the teeth of the two models into correct articulation. This is represented in Fig. 84.

The pieces should then be secured in this position with plaster and the two models placed in an articulator.

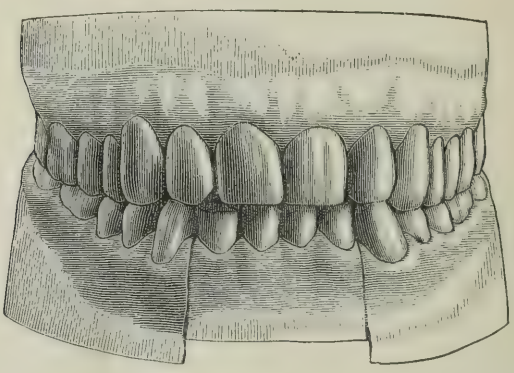
Fig. 84.



Forming the Splint in Wax.—Any interdental dovetail spaces should be filled with soft plaster, so that the splint when finished can be readily adjusted and removed.

The articulator should now be arranged (by the set screw

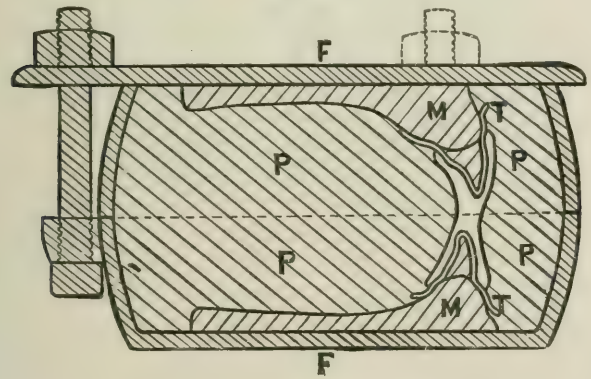
Fig. 85.



in the back) so as to open the bite about half an inch. Carefully cover teeth and gums of both casts with No. 60 tin-foil. Over this covering of tin-foil build up the splint in wax. This is best done as directed by the late Dr.

Alonzo Beal.* First, place two layers of thin base-plate wax over the teeth of both models, allowing it to extend just beyond the necks of the teeth upon the gums, but not quite to the edge of the tin-foil. Then make a strip of wax about three-sixteenths of an inch thick and wide enough to fit between the pieces of wax on the models, and long enough to extend as far back as they do, joining the three pieces together with melted wax. Pass a hot spatula all around the edge of the wax, where it joins the tin-foil, to make a perfect joint. The object of the tin-foil is to make the rubber smooth, and to have the splint, when finished, a trifle larger than the natural teeth, so that it will pass in position without binding at any point.

Fig. 86.

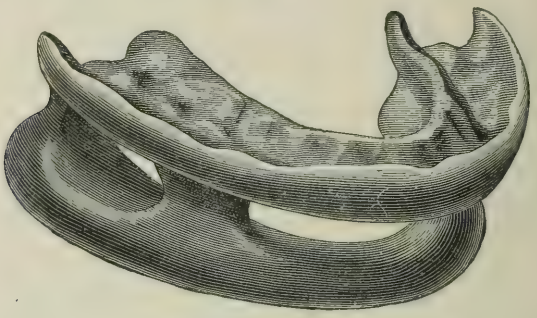


Flasking.—The wax splint and tin-foil covering now being one piece, should be removed from the models and the models carefully taken from the articulator, trimming their bases and sides if necessary, so that when the splint is in position on them the whole will fit in the vulcanizing flask. The lower model with the splint upon it should be

* See American System of Dentistry, Vol. II.

flasked first, and the investment allowed to extend half-way up the splint. Trim, varnish, and oil. Place the upper model in position in the splint and finish flasking. By allowing the tin-foil to extend beyond the wax (as at T, Fig. 86) the investment holds it in position when the wax is removed. Fig. 86 gives a sectional view of the flask with the splint invested. F represents the flask; M, the models; P, plaster investment; T, tin-foil coverings of the teeth extending beyond the wax splint; W, wax model of splint. Before opening the flask, place it in hot water to

FIG. 87.



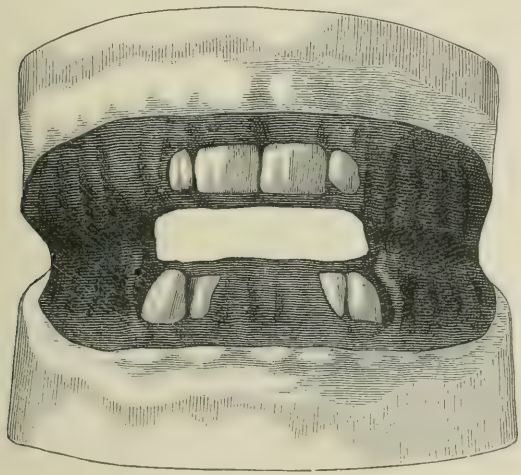
soften the wax. Separate the sections carefully. Remove the body of the wax splint, with a spatula, and wash the remaining wax out by pouring boiling water upon it; instruments should not be used about the teeth, as they are liable to injure the tin-foil.

Packing and Vulcanizing.—Liberal outlets for the rubber should be made in both sections. Cut the rubber into thin strips and soften over boiling water. It is also advisable to cut up a piece of previously vulcanized rubber, small pieces of which may be packed in between the other rubber at the thickest points, making it less liable to become porous in vulcanizing. Pack each section carefully and thoroughly a little more than full. Place the sections together, boil,

and close them in the usual way. In vulcanizing, allow the mercury one hour to rise to 320° F. When this point is reached the temperature should be kept uniform for one hour or more.

Finishing.—When the flask is taken from the vulcanizer and has become cold, carefuly remove the plaster and tin-foil from the rubber. In trimming, the rubber should be cut away nearly to the necks of the teeth and the edges all

Fig. 88.

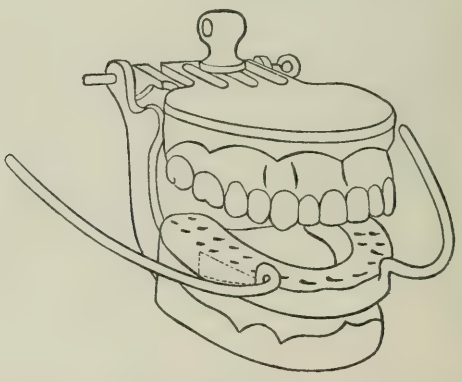


nicely rounded. The opening made in the splint for feeding purposes should be in front if possible, and large enough to allow for the free passage of a feeding-tube and should have the edges well rounded. The entire piece should be nicely polished, and no ragged or sharp edges left. Fig. 87 represents the completed splint. It is often advisable to make openings through the top or side of the splint against several teeth adjoining the fracture, so that it can be determined when the fractured surfaces are in place. This plan is represented in Figs. 87 and 88.

Securing Splint in the Mouth.—The splint is now ready to be adjusted in the mouth, and if the foregoing instructions have been closely followed the teeth of the superior jaw will readily slip into place. After so placing it, carefully manipulate the lower jaw, *reducing the fracture and bringing the teeth to position in the splint.* The jaw should then be firmly secured by external bandages.

The Kingsley Splint.—A splint devised by Dr. Norman W. Kingsley consists of a vulcanite covering to the lower teeth, having two steel wires attached extending out of the corners of the mouth and then backward along the cheek on a line with the teeth. It is held in position by having

FIG. 89.



the wires bound to a sub-mental splint of padded wood. The upper teeth must articulate with the upper surface of the rubber, so that the patient can use it for mastication. Take upper and lower impressions; pour models and articulate them, as before described, and place them in an articulator. Upon the lower model carefully press a piece of wax about one line in thickness over the teeth, allowing it to encroach a little upon the gums. Close the articulator to make the imprints of the upper teeth in the wax. The best method

to make the arms is to use a couple of old dental excavators. Flatten the ends which are to be embedded, and curve them carefully, so that they will pass out of the mouth and extend backward without pressing hard on the corners of the mouth, and terminate near the angle of the jaw. The flattened ends should be made quite broad, and be thoroughly embedded in the splint, as much strain comes upon them. Fig. 89 represents this form of splint.

APPLIANCES FOR THE CORRECTION OF DENTAL IRREGULARITIES.

Orthodontia is that branch of dental science which pertains to the correction of irregularity or malocclusion of the human teeth.

The growth of this branch of dental practice requires special study, investigation, and training in order to successfully practice it along advanced lines; every student should therefore make himself thoroughly familiar with the subject before attempting its practice.

Our purpose here is to introduce a few of the more important methods involved, with the manner of constructing the appliances, as a stepping stone for students to the study of the more exhaustive works.

Mechanical Forces.—The operator in this field of practice has an opportunity to utilize his knowledge of physics and the laws of mechanics. As a very able writer, Dr. Eugene Talbot, says: These laws are founded upon the action of simple elements which are interposed between the moving power and the resistance, for the purpose of changing the direction of the force. These are called mechanical powers, and are divided into two primary elements, the lever and the inclined plane. The principle of the lever is

the basis of the pulley, the wheel, and axle. That of the inclined plane is the basis of the wedge and screw.

Elasticity, as shown in India-rubber and the spring of metals, although not classified with the primary forces in mechanics, plays an important part in the application of force in regulating teeth. When these laws and their applications are firmly fixed in the mind of the operator, he can readily take advantage of the one which should properly be applied, or, when necessary to apply more than one, can combine them in such a manner as will best accomplish the desired result.

Materials Employed.—The materials employed in regulating are platinum, platinized gold, iridio-platinum, gold, German silver, steel, vulcanized rubber, soft rubber bands, compressed wood, sea-tangle, and silk, linen, or cotton ligatures.

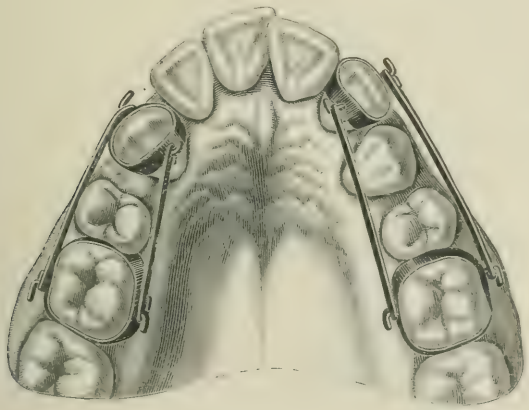
The most frequent forms of irregularity are protrusion of the cuspid teeth, misplaced bicuspids, contraction of arch, protrusion of the upper jaw, protrusion of the lower jaw, torsion, and lack of anterior occlusion.

Protrusion of the Cuspid Teeth.—In correcting this form of irregularity, which is possibly the most frequent met with, we have to decide from other existing circumstances whether the enlargement of the arch is indicated or the extraction of a tooth posterior to the cuspid. Frequently the former is called for, but there are cases coming to our hands where the latter, or the simple extraction of a tooth on one side of the mouth, or both is all that is required. If the upper arch is large enough, the extraction of the first or second bicuspid teeth will allow the cuspid teeth in a young person to move down and back into place unaided. Where it is desired to hurry the operation, or where the bone is too hard to permit nature to move the tooth sufficiently, appliances as are illustrated in Fig. 90

and 91 are usually employed. Fig. 90 shows Professor Guilford's method, which is one of the simplest and most effective.

A platinum band, with short gold wires soldered to the buccal and lingual surfaces, is cemented to the tooth to be moved, while a similar one is attached to a molar or other anchor tooth. The wires on the anterior band are bent forward, and those on the posterior one are curved backward. Two rubber rings, caught over the gold hooks, connect the two bands and yield the tractile power required.

FIG. 90.



These rubber rings can be removed and replaced for cleansing the teeth, or can be renewed at will by the patient. Two rings can be attached to each pair of hooks, if greater power be required, or the same object can be attained by cutting wider rings from thicker tubing.

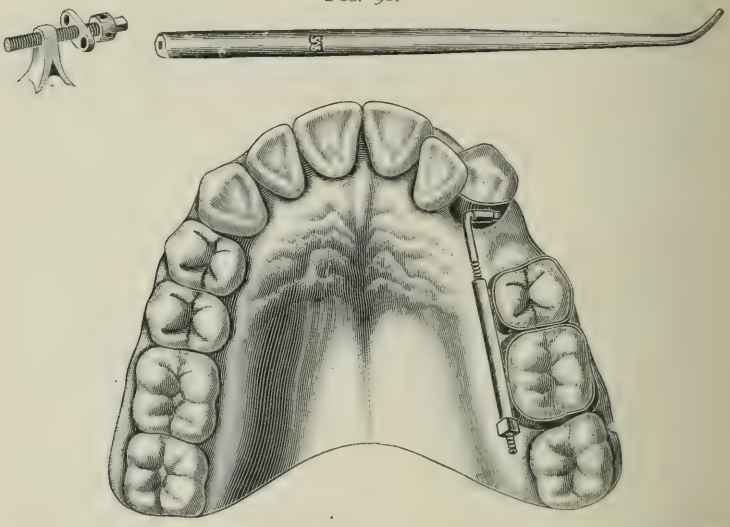
Fig. 91 illustrates another simple appliance for drawing a cuspid backward and inward. This was devised by Professor E. H. Angle, and is a part of what is known as the "Angle system of regulating."

The first molar is encircled by a metallic band, to which

is soldered a piece of tubing to accommodate the traction bar or screw. A band is also fitted to the cuspid; to this a short tube is soldered on the palatodistal portion, into which the bent end of the traction screw bar is engaged. The nut, which is operated against the distal end of the tube, will readily move the tooth into position.

We sometimes meet with obstinate cuspid teeth, which refuse to drop into line after the necessary room has been

FIG. 91.



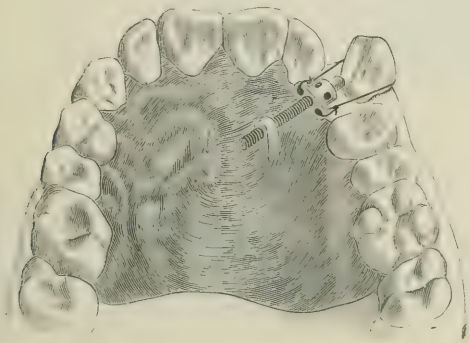
secured for them. When this is the case, an appliance, such as is illustrated in Fig. 92,—the pull-back jack-screw devised by Dr. F. H. Lee,—answers the purpose admirably.

The post or nut shown in the side cut is set in position and held by vulcanizing into a rubber plate as shown in the illustration; the screw-bolt is then placed through the post and a wire is passed around the tooth, the ends being secured to the holes in the cross-head or swivel-block. The wire is then taken up and tightened as the tooth is brought into place. To prevent the plate from being moved out of

position by the strain upon it, it should be secured to the teeth of the arch by ligatures.

Correction where Cuspid Tooth is Inside the Arch.—The power usually necessary to move an inlying cuspid is very great. The jack-screw is therefore one of the best forms of appliance; this, however, may sometimes be aided by what is known as the inclined plane. Dr. Angle's method is shown in Fig. 93. The base of the tube containing the screw-bar, or jack-screw, is soldered to a band encircling

FIG. 92.



the opposite cuspid and reinforced by a spur resting against the first bicuspid (see illustration), and also by the large traction screw, which is hooked into a pipe soldered to the labial surface of the band and passing in front of the incisors through a tube soldered to a band on the labial surface of the lateral incisor, against which the nut works. In this case, the left central and lateral were moved forward in the line of the arch, thereby closing the space between the centrals, and, at the same time, providing space for the out-moving cuspid. The large screw was beaten flat and polished before insertion.

The Inclined Plane.—One of the earliest methods employed in correcting or aiding to do so, where the superior

cuspid or incisor teeth were interlocked, was what is known as the inclined plane. This is formed of metal, by first

Fig. 93.

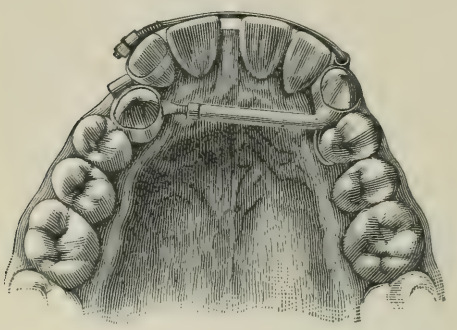
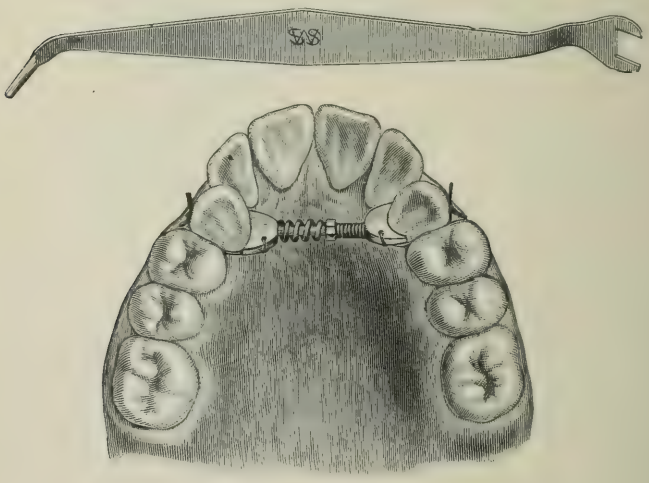


Fig. 94.

Inclined Plane.

striking up a saddle to cover two or more of the lower incisors. To this, at the desired point, is soldered an inclined

Fig. 95.



piece of heavy metal so directed that when the appliance is cemented in position, the inlocked tooth will strike upon it

in mastication and be forced outward into line. Fig. 94 shows a form of this appliance.

Another device for forcing the cuspids out into line is the ordinary jack-screws, of which there are several forms on the market. Fig. 95 represents the Holmes appliance in position. It is a combination of the spring and screw and is operated by the nut-fitting ends of the wrench; the turning of the screw causes a forceful spring action to the extent only of the screw thrust, and so avoids the common danger of spring action, which, if neglected, may carry the tooth too far.

Misplaced Bicuspids.—A simple method of moving a bicuspid out into line is the small jack-screw of the Angle system.

Fig. 96.

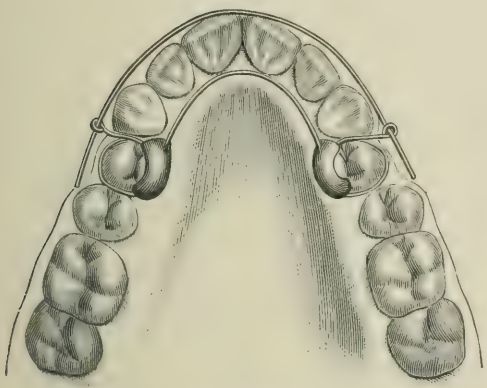
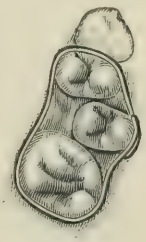


Fig. 97.



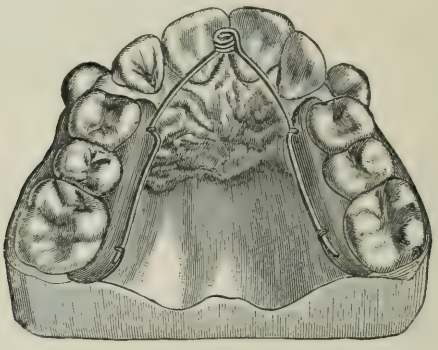
Another very ingenious method is the Jackson crib and spring appliance. Fig. 96 shows such an appliance in position. A base wire is shaped to the lingual side of the anterior teeth and anchored to the bicuspids by means of a single "crib" appliance. To each of these latter is attached a hook or eyelet to sustain a straight bar of spring wire that is sprung over the anterior teeth.

Dr. Jackson gives another very simple fixture for the pur-

pose of moving a single bicuspid either inward or outward. It is shown in Fig. 97.

A spring wire is bent in the form of a crib surrounding the misplaced tooth and an adjoining one on each side, passing well up toward the gum on the labial and lingual sides, with the ends of the spring wire terminating and overlapping upon the tooth to be moved. The elasticity of the spring will exert enough force to move the tooth.

Fig. 98.

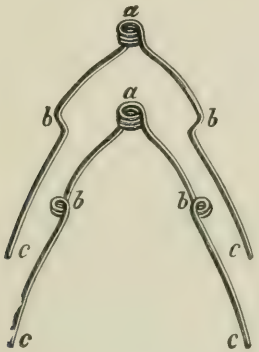


Contraction of the Arch.—The enlargement or correction of contraction of the arch, by lateral expansion, may be accomplished by a number of methods. Older practitioners usually make use of the Coffin split plate, but as far as possible heavy, cumbersome appliances should be discarded. Among the neatest and most effective for this purpose are those devised by Dr. Eugene Talbot and Prof. Angle. Dr. Talbot's method is as follows:—

A vulcanite plate is made to fit the teeth and alveolar process, and cut away so that the anterior parts extend far enough forward to enclose the teeth to be moved. See Fig. 98. A piece of piano wire is bent into either of the forms shown in Fig. 99, wherein *a* is the coil and fixed point; *b b*, movable arms extending from *a*, and *c c*, movable arms

extending from *b b*. Grooves are cut into the anterior and posterior parts of the plate to correspond with and receive the points *b b* and *c c*. Holes are drilled at these points, and the wires tied to the rubber plates. In order that the anterior teeth may be moved with the greatest force, the arms are so adjusted that the greatest pressure is exerted

Fig. 99.



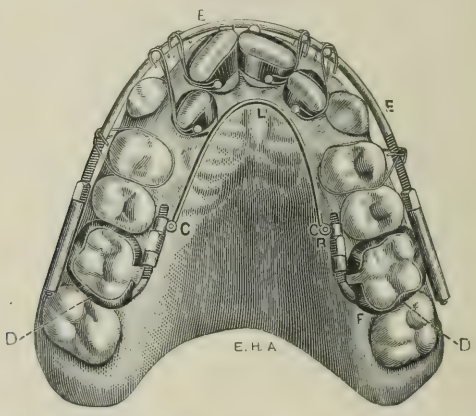
on the anterior parts of the plate. This appliance is readily removed for cleansing and returned to place by the patient.

Dr. Angle's method utilizes the principle of the spring without the objectionable features of the rubber plate, combined with an "expansion arch." Fig. 100 shows a complex case, necessitating force from several directions upon the badly malposed teeth. The dental arch requires widening, the centrals and lateral incisors are to be carried forward and outward and rotated. It will be noticed that wire ligatures are looped over spurs or pins, which have been soldered to the lingual sides of the bands, nearly at the distal angle, thus exerting a pressure as they are occasionally tightened by twisting or renewal. This tends to rotate the teeth, as well as move them forward and outward into harmony with the pattern of the expansion arch. The exact direction of this force is controlled by little spurs attached

at the desired points to the expansion arch, which thus prevent the ligatures from slipping down the sides of the arch. The nuts in front of the anchor tubes are occasionally tightened as more room for the moving teeth is required, thus carrying all four teeth forward with the positive force of the screw. The action is practically that of two jack-screws united.

As the expansion arch is very elastic, it exerts a powerful lateral force upon the sides of the dental arch, through the anchor bands and the ligatures upon the bicuspids. By

FIG. 100.



studying this figure it will be seen how perfectly force is being distributed to accomplish these various tooth movements, and how, as in all fine mechanisms, each part assists and harmonizes with each other part.

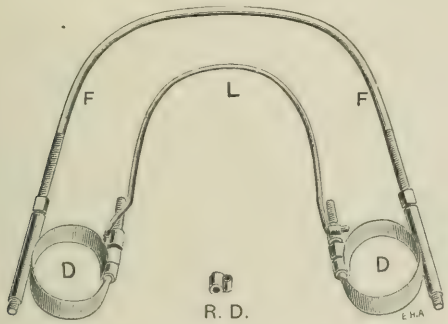
In describing this appliance Dr. Angle says that occasionally the tooth which it is desired to use as anchorage may be found to incline forward at such an angle that the sheath on the " D band " will not properly line with the expansion arch, in which case the band should be removed and the sheath be detached and resoldered at the proper angle. This may be readily effected by placing a small piece of

solder and borax at the union of the band and sheath, applying heat and turning the band as desired. It is, however, rarely necessary, as by slightly bending the arch and shifting the band, it can in most instances be properly adjusted without changing the position of the tube.

The proper alignment of the sheaths is best effected by slipping the ends of the arch into them before firmly clamping the bands.

In order that the patient may become gradually accustomed to the appliances, the bands should be worn for two or three days loosely clamped about the teeth, then the arch added without ligatures for three or four days more, and

FIG. 101.



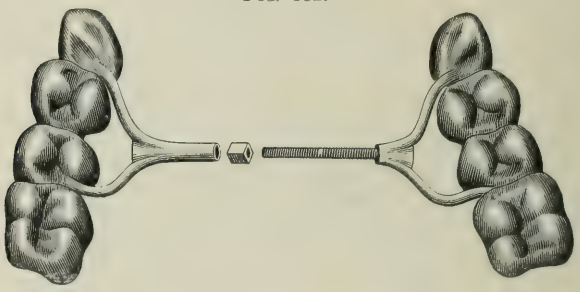
finally all carefully and thoroughly adjusted and the ligatures applied for the movement of the teeth. They should be very light of tension at first. If this be done, the patient will be more tolerant of conditions during the progress of the movement.

The elasticity of the arch is sufficient to exert ample force for widening either of the dental arches, yet in some instances where the patient has reached maturity the force may not be sufficient to accomplish the desired movement as rapidly as may be wished. To meet this limitation we have devised the reinforcement arch L, which should be

adjusted to exert pressure upon the lingual surfaces of the anchor bands, as in Figs. 100 and 101. Attach on each side in the manner following: unite two short tubes at right angles, R and D; slip the longer one over the end of the screw of the clamp band D; bend the end of the lever sharply at right angles and engage it with the short tube. Any desired degree of force may be easily gained with this simple method of reinforcement.

Another and very excellent method of spreading the arch is that devised by Dr. C. Heydenhauss.* The doctor's method as he described it to the author consists first, of capping the teeth on both sides of the mouth, from the

Fig. 102.



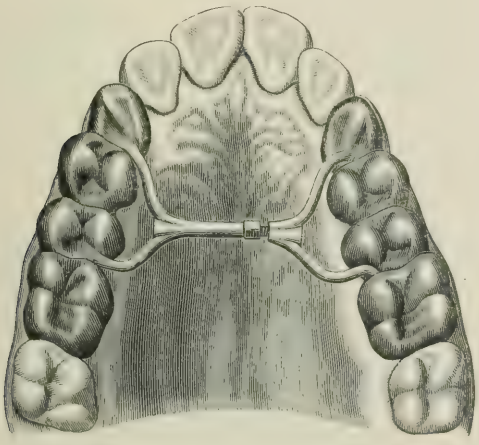
cuspids back to the second molars, with continuous shell-crowns. These crowns are constructed of one continuous piece of gold plate, 22-carat. The cuspid teeth, however, if they are to be forced outward, only need covering on the palâtine surface. This is all clearly shown in Fig. 102. After the crowns are well fitted and finished, two platinized gold bars are soldered to their palatal surface and shaped according to the form of the palatine vault. To one side a heavy screw-bar is soldered, while to the other a short hollow tube, to receive the free end of the screw-bar, is

* Dentist to the Court of H. R. M., the Grand Duke of Sachsen-Weimar.

attached. The screw-bar is provided with a nut, which, after the crowns have been securely set with cement, is turned up on the bar until moderate pressure is exerted. This nut is then given two or three turns, three or four times a week, according to the case in hand. The appliance in position is shown in Fig. 103.

When it is desirable to expand the lower maxilla, continuous crowns are made as has been directed, but to each of these an open cylinder is soldered to the lingual surface.

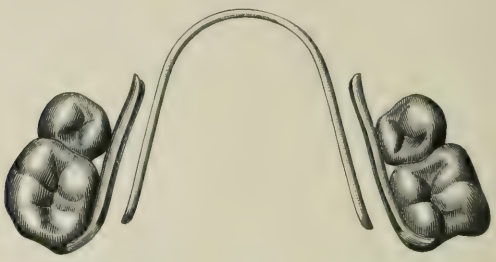
Fig. 103.



This is done by fitting and soldering a gold tube over a piece of piano-wire of the same size as the wire which is to exercise the traction. After this is done, the gold tube is cut in its long axis, by which we get the open cylinders. The posterior ends of these tubes are closed so as to receive the ends of the traction wire when in position. When the crowns are secured in position with cement, a piece of piano-wire, previously shaped from the cast or die, is sprung into the open tubes. To exercise the necessary traction, the wire must be slightly spread before placing it in the mouth.

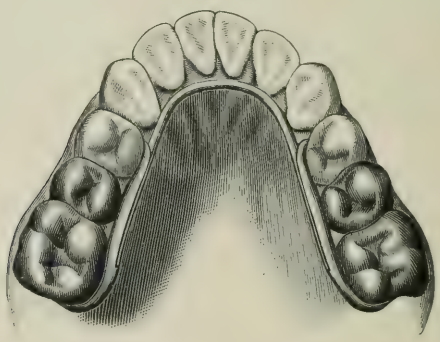
The placing of this wire requires some skill, but is, however, easily understood. To prevent oxidation the wire can be gold-plated. The wire should be taken out every two or three days and slightly expanded, then replaced. This appliance is shown in Figs. 104 and 105.

Fig. 104.



Protrusion of the Upper Jaw.—One of the simplest and most efficient methods of reduction in superior protrusion is that given by Dr. Angle. It consists of anchor-bands (D, Fig. 106) for the molar teeth, with long tubes soldered

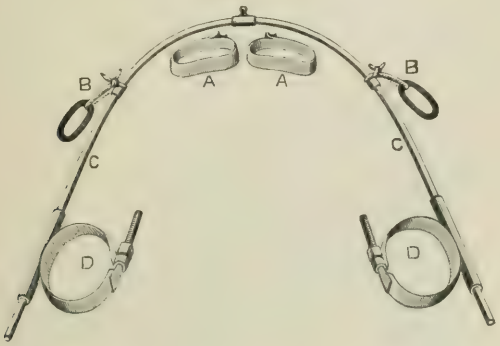
Fig. 105.



to their buccal surfaces to receive the wire bow-spring, which rests in front in notched projections upon bands cemented to the central incisors. At the center of the bow-spring is soldered a short tube, having upon its labial sur-

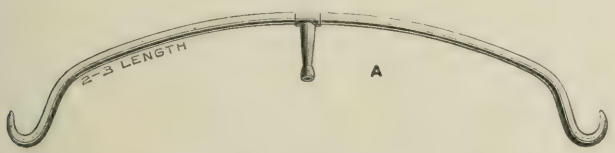
face a rounded projection to receive the standard (cupped at its free end) of the long traction bar, Fig. 107. In use, the clamp-bands (D) are attached to the anchor-teeth, and the plain bands cemented to the central incisors. The bow-spring is now placed in position.

Fig. 106.



Occipital resistance is obtained by means of a netted cap, fastened to a circle of wire fitted to the head, to which are attached rubber bands. When the cupped standard of the traction bar has been placed over the central spur of the bow-spring, the rubber bands of the cap are drawn forward and looped over the curved ends of the traction bar, as

Fig. 107.



shown in Fig. 108. This cap, traction bar, and rubber bands are worn only at night, on account of their conspicuousness.

During the day, rubber rings (B, Fig. 106) are caught over the tubes on the molar bands and secured by ligatures

to projections on the bow-spring in the region of the cuspid teeth.

The appliance in position, as worn during the day, is illustrated by Fig. 109. After reduction of anterior protrusion we are met with the difficulty of retaining the results gained. Although the posterior teeth in many cases will not furnish the resistance necessary for drawing the anterior teeth inward, they will usually answer perfectly

FIG. 108.

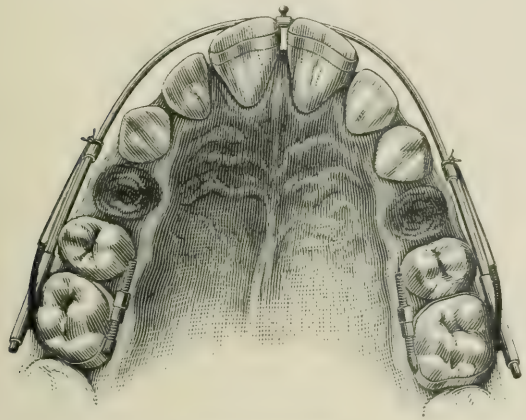
NIGHT APPLIANCE.

for retaining them afterward. Attachment can be made to them either by means of a rubber plate covering the roof of the mouth and extending around their distal surfaces in the form of a clasp, or by means of metal bands cemented to them. In the former case a small round or half-round gold wire may be made to pass around the arch, touching the regulated teeth on their labial surfaces, and be attached at each end to the rubber plate at convenient points, as where teeth have been extracted. In the latter case a similar re-

taining wire may be soldered to the molar bands, or the bands may have tubes soldered to their buccal surfaces and the wire, threaded at the extremities, passed through these and retained by means of nuts operating upon them. In either case the retaining wire should have short gold clips attached to it in front to engage with the cutting edges of at least two of the incisor teeth.

When it is desired to avoid having a retaining wire pass

FIG. 109.



DAY APPLIANCE.

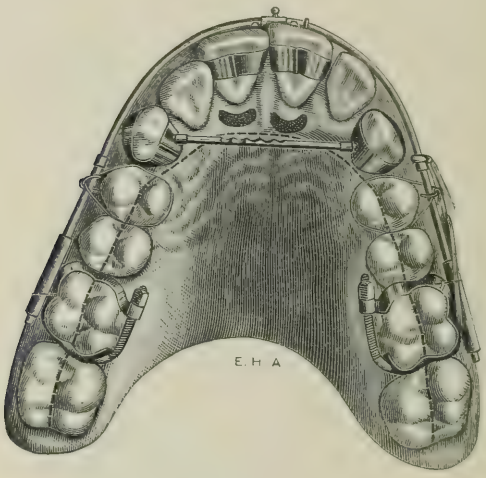
entirely around the front of the arch, a rubber retaining plate may be made with a gold T passing between the centrals and long enough to rest upon all four of the incisors. Holding these teeth firmly in place will also keep the cuspids in line through lateral pressure.

This same treatment with some modifications is shown in Fig. 110 taken from Dr. Angle's practice. The dotted line shows the relation of the lower teeth. The arch is held in place by the anchor bands D, upon the first molars as in the former case. In order to widen the arch in the region of the cuspids and bicuspids, at the same time the incisors

were being retracted, the bicuspids are laced to the wire arch and the cuspids are spread by means of a jack-screw, or may also be laced to the arch. Rubber ligatures are applied as shown on the left side of the arch in the illustration.

Sections of bone were cut from the palate as indicated by the crescent-shaped markings, in order to expedite the movements of the central incisors. Force was exerted upon the

FIG. 110.



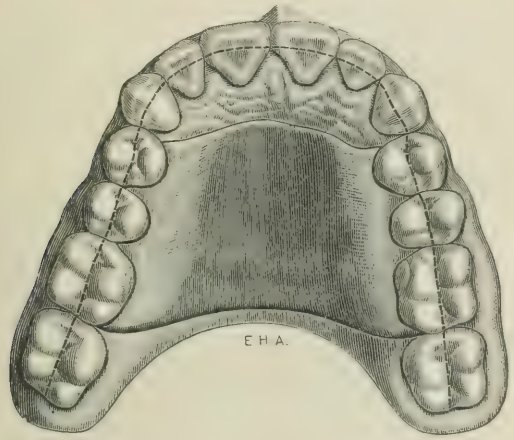
incisors by means of the head-gear in the usual way, and in this case, it being desirable to make tooth movements as rapidly as possible, the head-gear was worn almost constantly for six weeks. The next illustration (Fig. 111) shows the remarkable results at the expiration of that time. The relation of the lower teeth is here also indicated by a dotted line.

Protrusion of the Lower Jaw.—When this deformity is slight, it may usually be corrected by drawing the lower incisors in and the upper ones outward. Where the case is a pronounced one, there is no remedy except the retraction

of the entire lower jaw. In many cases, however, the two measures can be combined to advantage.

Method of Retraction.—It was for many years supposed that the retraction of the inferior maxillary was brought about entirely by a change effected at the angle of the jaw; but some years ago it was noticed by Prof. C. N. Peirce, that where sufficient pressure was brought to bear, a change was brought about in the temporo-maxillary articulation.

FIG. 111.



That is, if pressure was continued at the mental region, it would cause resorption of the posterior wall of the glenoid cavity, thus permitting the condyles to recede, and articulate somewhat posteriorly to their former positions.

Through this fact, and the change that is brought about at the angle of the jaw, we are enabled to correct one of the most unsightly of dental deformities. The method of procedure is well illustrated by a case brought before the Odontological Society of New York by Dr. Geo. S. Allen. He says, in part: "As will be seen from the photograph (Fig. 112), taken at the time the patient was wearing this

apparatus, it consists of two parts. For the lower part, I made a brass plate to fit the chin, having arms with hooked ends reaching to a point just below the point of the chin. These arms were arranged in such a way that the distance between them could be altered at will by simply pressing them apart or together. The upper part consisted of a simple network, going over the head and having two hooks on each side, one hook being above and the other below the

Fig. 112.

ear. When this apparatus was completed and in use, there were four ligatures of ordinary elastic rubber pulling in such a way as to force the lower jaw almost directly backward. The work proceeded very rapidly, so that at the end of two months the irregularity was almost entirely cured."

A very good method of making the chin piece—Dr. Guilford's method—is to take a plaster impression of the chin and from this make a model. The model is then overlaid

with a piece of trial-plate wax, from which, after being varnished, a mold in sand is obtained and a die and counter-die made. Between these a piece of soft and heavy brass plate is struck up and drilled full of holes. After fashioning heavy piano wires to cross the plate and extend sufficiently beyond to form hooks, they are soft soldered to the brass plate and the latter covered with black silk with a thick layer of cotton batting laid between the two. The enlarged size of the chin piece will admit of this. The piece thus padded will fit the chin and be soft enough to prevent pain when pressure is brought to bear upon it.

Torsion.—"The term torsion, as applied to the teeth, signifies that condition in which a tooth is found to be

FIG. 113.

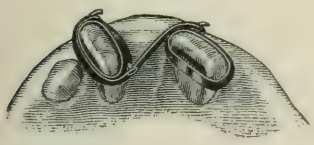


FIG. 114.

turned upon its axis. Rotation refers to the act of twisting or turning a tooth so as to bring it into normal position. Torsion, therefore, describes the condition, and rotation the operation."*

Rotation by Rubber Ring.—In the accompanying illustration, Fig. 113, Dr. Guilford's method of employing bands and rubber rings for rotation is given. Platinum bands were fitted to the centrals, with a gold hook soldered to each at points that would furnish the greatest amount of tractile power. After the bands were cemented in place a rubber ring was stretched from tooth to tooth, in the manner shown in Fig. 113. The malposed tooth was thus readily brought into contact with its fellow, and at the same

* Guilford's "Orthodontia."

time considerably straightened. After which it was retained by the retainer shown in Fig. 114.

Rotation by Spring Bar.—Where the mesial angles protrude double rotation can be accomplished by the very simple and effectual method.

Upon each of the teeth to be rotated place bands with tubes soldered to their labial faces near the distal angles. One tube is set vertically and the other horizontally. A short piece of piano or German silver wire, bent to a right angle at one end, is inserted in these tubes, and rotation is effected by the elasticity of the wire (Fig. 115). Once in position, the teeth are retained by inserting in the tubes a suitably shaped piece of non-elastic gold wire.

Fig. 115.

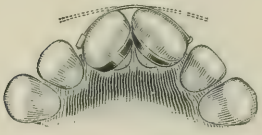


Fig. 116.

Another Method of effecting double rotation, recommended by Dr. Angle, is shown in Fig. 116. This is a combination appliance, consisting of bands with spurs soldered to their mesio-labial angles to engage a wire ligature, as shown in the illustration. After the bands have been securely cemented in position a piece of rubber is stretched between them, and the wire ligature is applied and tightly drawn and the ends twisted together. By the occasional renewal of this wire a powerful force is exerted which will readily turn the teeth. After the teeth have been brought to the desired position a temporary retention is effected by the application of a fresh ligature and dispensing with the rubber.

Lack of Anterior Occlusion.—This form of irregularity is fortunately rare, as it is one of the least amenable to treat-

ment. The cause is usually the lack of alveolar development in the anterior portion of the mouth, sometimes accompanied with an excessive growth in the molar region.

Treatment.—When the deformity is slight it may be corrected by grinding off all the antagonizing points from the posterior teeth, thus shortening the bite, bringing the anterior teeth closer together. If the third molars were in position and adding to the trouble they should be extracted. Then, if necessary, one or more of the remaining molar teeth upon either side of the mouth (those in the poorest condition to be selected) may be devitalized, ground down beyond the point necessary, and then covered with gold crowns.

Where considerable grinding upon vital teeth is done and the exposed dentine becomes quite sensitive, it may be obtunded by a repeated application of either chlorid of zinc or nitrate of silver.

Retention and Retaining Devices.—The tendency of teeth which have been regulated is to return to their former malposition. Retaining devices are therefore designed to hold the teeth in their new position until they become permanently so fixed by nature. Fixtures of this nature should be made as delicate and inconspicuous as possible, consistent with perfect support. The force or antagonism exerted to overcome the tendency to a backward movement is not very great, but it must be constant. That is a retaining appliance should, as a rule, be made stationary by carefully fitted and cemented bands. It should also be made with as little bulk as possible that it may more readily be kept clean by the patient, and should be inspected occasionally by the dentist to see that it is kept clean, that no injury may come to the teeth.

The time required for mechanical retention varies according to the age of the patient, the movements which have

been accomplished, the health of the surrounding tissue, the occlusion of the teeth, etc. In some cases, as where the upper incisors have been moved from a lingual to a normal occlusion, a few days' retention will suffice, as the occlusion of the teeth will support them in their new position. There are other conditions, as for instance, where the anterior upper teeth had been retracted, a much longer time, from six months to a year, being necessary. This is true particularly in cases of rotation, where, owing to the severe disturbance of the fibers of the peridental membrane, a mechanical retention of a year or more is usually advisable. This would apply to patients eighteen to twenty years of age or more; if the patient was but twelve years of age possibly half that time, or six months, would be all that was necessary.

The class of anchorage, or retaining device, depends upon the nature of the irregularity corrected.

1. Where the tendency of the teeth is to move in different directions, we may use a reciprocal appliance. That is, the bracing of one tooth against another.

2. The use of teeth already firm in the arch for anchorage.

3. Removable devices, such as rubber plates, with attachments.

4. The correct occlusion of the teeth.

When a single tooth has been rotated, a small band and a short projecting wire or spur will retain it in position. It is probably better, however, to have two spurs, as shown in Fig. 117. When two approximating teeth have been rotated in opposite directions, a simple but very effective retainer is to make a thin gold band to fit each tooth, tack them together with a little solder, then cement in position. A more complicated case of rotation, inolving the centrals and lateral incisors, could be anchored by a very simple but

effective device, suggested by Dr. Angle. This is shown in Fig. 118. It will be noted that there are two thin gold bands connected by a spur, with an additional small spur made to bear upon the mesio-labial angle of the lateral incisor. The ends of the long spur or wire are secured by small tubes soldered to the lingual surfaces of the bands, as

Fig. 117.

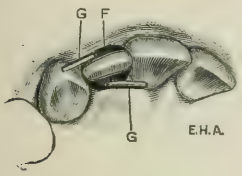
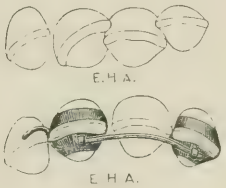


Fig. 118.



shown in the illustration. Direct attachment of the ends of the wire to the bands by solder is, however, preferable. A more complicated case of torsion, and the means of retaining the teeth in position after treatment is suggested by Dr. Angle and shown in Fig. 119. This is simply an-

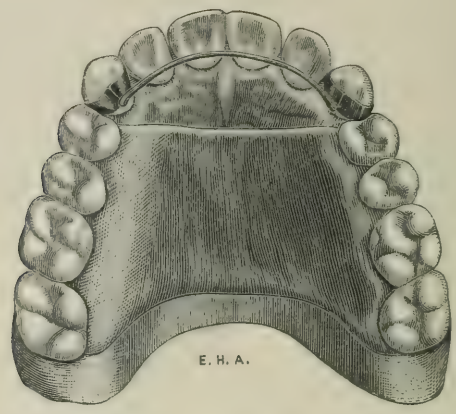
Fig. 119.

other form of the principle of two bands and spurs united. It demonstrates, however, the extent to which this simple appliance may be applied.

When the upper arch has been spread, the simplest form of retention, and at the same the most practicable, for the

bicuspids and molars, is a neatly fitting rubber or metal plate. If the anterior teeth have been moved at the same time, the plate should not extend far enough forward to

FIG. 120.



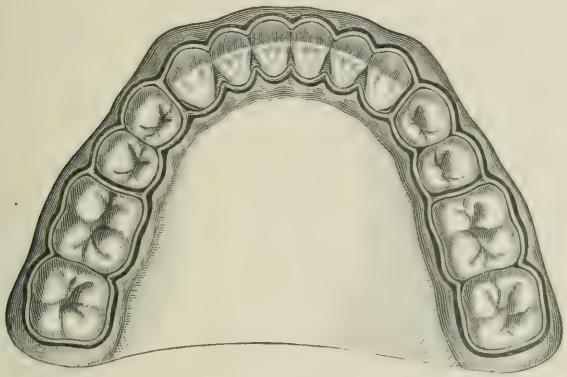
rest against these teeth. The plate is unreliable for the retention of the incisors and cuspids, owing to their sloping surfaces. When we have this condition to meet, a com-

FIG. 121.

bination of retaining fixtures, a plate for the bicuspids and molars, and the bands and bar for the incisors and cuspids, as indicated in Fig. 120, is the most satisfactory.

A very neat and satisfactory retainer for the lower jaw is represented in Fig. 121. It is simply a wire crib, and can be constructed of platinized gold wire. The wire is bent with pliers and clasp-benders to fit the labial, buccal, and lingual surfaces of the teeth accurately. This is best done on a die. A smaller wire is then accurately fitted at inter-

FIG. 122.



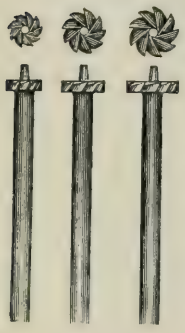
vals and tacked to the two base wires with a little gold solder. These small wires rest in between the teeth on the masticating surface, holding the base wires against the teeth and at the same time preventing them from being worked down into the gum tissue. The whole appliance should be so closely fitted that considerable pressure will be required at first to force it home, as shown in Fig. 122.

CROWN- AND BRIDGE-WORK.

Preparation of the Root for an Artificial Crown.—All remaining portions of the natural crown should first be removed with suitable instruments. If the cervical portion of the tooth is comparatively sound and unbroken, this may be most expeditiously accomplished, and with less risk of

injury to the root, by cutting two parallel grooves, opposite each other, on the labial and palatal surfaces, with a small circular saw, or a hard rubber or rubber and corundum disc. These grooves should be cut through the enamel deep into the dentine. Then with the excising forceps, the cutting edges of which are placed in the groove, the crown is readily severed from the root.

Fig. 123.



After the use of the discs and excising forceps, any remaining portions projecting beyond the free margins of the gum should be removed and proper shape given to the end of the root. A flat-edged corundum stone, or what are known as the Ottolengui root facers (Fig. 123), are the best for the purpose. If stones are used they should be kept constantly wet and free from clogging particles of tooth substance. The end of the root should be dressed down, anteriorly, a little below the free margin of the gum, care being taken not to cause unnecessary laceration; in this way the artificial crown, when adjusted to the root, will unite so intimately with the gum in front, in ordinary cases, as to render exposure unnecessary. The surface of the root prepared in this manner will present a concavity corresponding with the festoon of the gum.

If a living pulp remains in the root, it will not ordinarily be practicable,— unless there is partial obliteration and consequent recession of the pulp cavity as the result of ossific deposits,—either to cut off the tooth on a line with the gum or even transversely, or to dress the root even with the gum, without inflicting insufferable pain. It will be necessary, therefore, under such circumstances, either to devitalize and extirpate the pulp through the carious opening in the

crown before the latter is removed, or (if not exposed by excising the tooth), through an opening into the pulp, made with a drill revolved by the dental engine, after excision.

Devitalization of the Pulp.—There are several ways of extirpating a dental pulp. One of the older and still not uncommon methods of operating consists, first, in devitalizing it with arsenious acid and then removing it with a broach. Another method practiced by some is to thoroughly expose the pulp, apply cocain, or neurocane, securely sealing this in the cavity with a piece of very pliable rubber,—a piece of unvulcanized rubber or artificial vellum or "palate" rubber. Pressure is then made with a large blunt instrument, such as a ball burnisher; applied gently at first and gradually increased. This pressure sends the anæsthetic into the dentinal tubuli and if continued for a few minutes the pulp in many cases may be painlessly removed.

Excision of Crown and Instantaneous Extirpation of the Pulp.—A somewhat heroic method, though one with which several operators have claimed much satisfaction, by which a living pulp may be quickly and successfully removed, with comparatively little pain, consists in cutting the labial and palatal grooves as has been directed, making them as deep as possible, without inflicting too much pain; then with the excising forceps, the cutting edges of which are inserted in these grooves, the crown is quickly severed from the root. This usually leaves the pulp fully exposed and paralyzed, when a piece of orange wood—previously cut and shaped to about the size of the canal, not larger, and the point saturated with carbolic acid—is carefully placed against the exposed point of the pulp and quickly driven with one light blow from the mallet into the pulp canal. When the wood is withdrawn, the pulp sometimes adheres to it; if not, it may be quickly removed with a broach. In this operation

the immediate paralysis induced renders it comparatively painless.

This operation, in the light of "Pressure Anæsthesia" referred to above, seems unnecessarily severe and cannot, therefore, be generally recommended.

Preparation of the Pulp Canal.—After the removal of the pulp the apical foramen should be thoroughly closed by any method usually employed in root filling. A neglect of this important measure will greatly endanger the success of the operation.

FIG. 124.

The proper treatment and preparation of the root having been thus far accomplished, the canal of the latter should next be enlarged for the reception of a dowel-pin. This is effected with an ordinary fissure drill or the Ottolengui root reamers (Fig. 124).

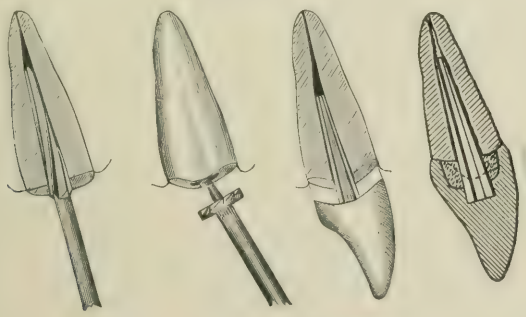
The natural opening in the root should be enlarged to the depth of two or more lines, according to the length of the root; and the orifice should be made large enough to admit a support of sufficient size to secure the crown firmly in position. The direction of the drill in cutting should follow closely that of the natural canal in the root, since but a slight deviation in this respect may endanger the integrity of the latter by too great a thinning, or actual perforation, of its walls. The face of the root should then be given a suitable shape for the reception of the form of crown to be attached, the methods of fitting and inserting which will now be considered; the simple or all-porcelain system being first taken up.

Porcelain Crowns.—The porcelain crown is especially useful where an inexpensive and quickly adjusted crown is necessary; or where some pathological condition would seem to limit the probable permanency of an operation, or,

again, where a temporary crown is desired, to serve, as is sometimes necessary, until the patient or operator can make suitable engagements for more permanent work.

The objections made to the use of this class of crowns for permanent work are that the pin or post upon which almost the entire support of the crown is thrown acts as a lever in the root canal, and sooner or later many of the weaker roots are fractured, thus ending their usefulness as a support; and again, the pin or post, entering, as it does, deeply into the body of the porcelain, weakens it at this point, and not infrequently do patients return with the crowns fractured through the center from the force of mastication. Then, again, unless a perfect joint is secured between the root and the crown, which, too frequently, is not accomplished and decay of the root follows, undermining the operation.

FIG. 125.

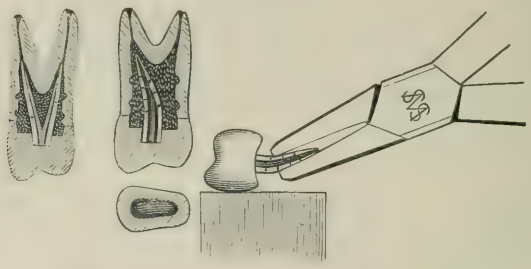


A general description of the Logan crown will be sufficient in this place, the principles underlying the adjustment of the several forms of porcelain crowns being practically the same.

The Logan Crown.—After all remnants of the natural tooth have been removed, the canal is enlarged to receive the pin of the crown, with suitable sized reamers. With a root facer a labial slope is given to the root end, so that the

crown neck shall fit under the edge of the gum. Fig. 125 shows the method and its result, and the cross-section shows how the cement incases the pin. The suitable preparation of the bifurcated roots of some bicuspids and of all the

Fig. 126.



molars is a matter involving difficulties of an unusual character and requiring good judgment. The feasibility of splitting the post of a Logan crown to adapt it to the bifurcated root of a bicuspid, and the adjusting of the crown to a single rooted bicuspid or where the bifurcation is not marked, as well as the best method of bending the Logan crown pin is exhibited in Fig. 126.

Fig. 127.

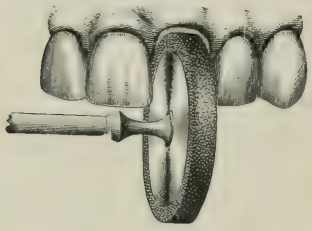
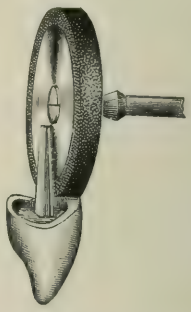


Fig. 128.



The fitting of a Logan crown to a root may be done with a wet corundum or carborundum wheel in the engine handpiece, as shown in Fig. 127. A safe-side corundum-wheel

can be used in the same manner. It also affords the greatest facility for the slight touches required to abrade the thin cervical borders of the crown (Fig. 128), which may by this means be done without encroachment on the post.

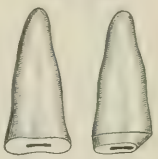
THE FERRULE OR COLLAR CROWN.

This crown was originally brought to the notice of the profession by Dr. C. M. Richmond, of New York, and is therefore ordinarily known as the Richmond Crown. Numerous modifications have been made, however, which enhance its value. The process of constructing the improved crown is as follows:—

Facing the Root.—The root must be trimmed down to about the gum-line, except the labial portion, which should be cut nearly a sixteenth of an inch below the gum margin. For this purpose, carborundum stones or the Ottolengui root-facers are employed, as described on page 160.

Removing the Enamel Ledge.—The ring of enamel remaining upon the root should be carefully and thoroughly removed (see Fig. 129), making the sides of the root parallel, so that the band, when applied, may *fit closely its entire width.* If this is not done, the band, even if a narrow one, instead of fitting closely will form a pocket beneath the gum margin, and will, in consequence of its irritating effect upon the surrounding tissues, cause more or less inflammation and possibly the loss of the root.

FIG. 129.



Numerous instruments have been devised for the removal of this enamel; among the most efficient are those invented by Dr. Calvin S. Case and Dr. Geo. M. Weirich. Fig. 130 illustrates Dr. Case's enamel cleavers. These are so shaped that they can be partially rotated under the margin of the gum, presenting a sharp point toward portions of the enamel

that will not easily clean off, with a view to fracturing it as the diamond cuts glass, breaking it up into small pieces which can readily be detached and the sides straightened and smoothed by the broad blade. The peculiarities of shape are shown in the enlarged cuts.

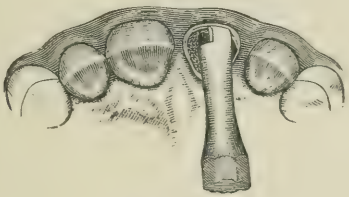
The Weirich cleaver, or chisel, is shown in Fig. 131.

Fig. 130.

With this instrument and a few gentle blows from the mallet the enamel is readily broken up and detached. The rubber cushion in the center of the chisel takes up the blow, thus relieving the root from unnecessary shock. In the accompanying illustration the instrument is shown in place ready to receive the blow from the mallet. It is a well-known fact that with most of the appliances on sale it is difficult to properly remove the enamel from the approximal surfaces of roots, especially where they are very close. With this instrument (to be followed with the ordinary cervical-wall chisel or the Chase cleavers) the root upon all sides can be readily and properly prepared for the reception of a band or collar with very little discomfort to the patient or trouble to the operator.

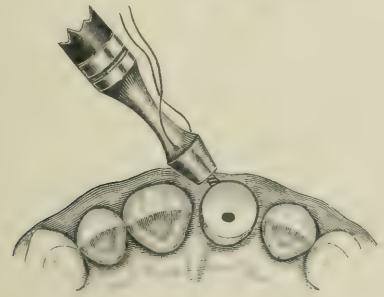
Taking Measurement of the Root.—After the enamel has been thoroughly removed, an accurate measurement of the neck of the root should be secured. Several instruments have been devised for this purpose. A simple form of dentimeter is shown in Fig. 132. The wire is turned

FIG. 131.



down to approximate the size of the root; it is then carefully slipped over the root and worked up under the free margin of the gum. Slight traction is now made upon loop by gently drawing upon the dentimeter, at the same time twisting it between the thumb and finger of the left hand; this will give a perfect twist and adaptation as shown in illustration.

FIG. 132.



Transferring Measurement to the Banding Material.—In order to transfer this measurement accurately to the banding material, cut the wire loop in the center and spread the ends in opposite directions, as shown in Fig. 133. It is

then laid on the piece of gold to be used for the band (which should be 22 k. and about 30 gauge); this should be cut the *exact length of the wire,* and about an eighth of an inch in width, unless for special reasons it is necessary to have it wider. This small strip of gold should now be annealed over a lamp or Bunsen burner, then with round-nosed pliers brought into a circular form, and with the fingers the ends should be carefully pressed by each other. This will form a slight kink in the band, so that the ends, if now gently drawn apart and let go, will spring accurately together ready for soldering, a butt-joint being stronger and for obvious reasons preferable to a lap-joint.

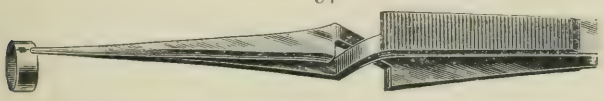
Fig. 133.

Soldering the Band.—In soldering the band, a corner of the two edges should be grasped with the soldering pliers, the joint should then be slightly coated with borax, and a small piece of 20 k. solder placed over it, *on the outside of the band* (see Fig. 134). It should then be held in the flame of a Bunsen burner until the solder flows, at which time it must be *instantly removed.* With a little experience and care in soldering in this way (over a Bunsen burner), it can be done more conveniently, in less time, and with much less danger of burning the band, than with the blow-pipe.

Fitting Band to the Root.—The band is now ready to be fitted or adjusted to the root. If the end of the root is not round, as is usually the case, the sides of the band can be flattened or otherwise shaped with slight pressure from the thumb and finger or with suitable pliers. The upper border should then be trimmed to conform to the shape of the alveolar process or the line of the gum-attachment; in many cases, unless the band is greatly depressed or cut out on the sides, it will be found that the gum will be detached from

the sides of the root, and that the process will be reached before the root is covered high enough on the labial and palatal surfaces. Place the band thus shaped upon the root, and if the measurement and each progressive stage have been accurately performed, it will be found to fit perfectly. Now press or drive it up carefully, until the point of attachment between the soft tissues and the root are reached (about one-sixteenth of an inch beyond the gum margin), which is shown by the slight whitening of the gum. When this is very marked upon any side, the band should be re-

Fig. 134.



moved and relieved by cutting it away at that point, and then readjusted. A corundum-wheel is now gently passed over the labial portion of the lower edge of the band, to bring it down with the face of the root and to render the band invisible when the crown is finished. In doing this the wheel used should be revolved *toward the root*, so it will not irritate the soft tissues, as it would were the force applied in the opposite direction,—and at the same time it will turn the feather-edge of metal over the end of the root.

Forming the Base Plate.—Cut a piece of gold (34 gauge) of suitable length and width, anneal, and then press it against the lower edge of the band with the fingers until it is nicely adapted; secure it in this position for soldering by three or four strands of wire, as shown in Fig. 135. Now paint the joint with borax dissolved in water, lay a small piece of 20 k. solder against the back or palatal portion of the band, *on the outside*, and hold it in the flame of a Bunsen burner until the solder flows, which will be seen to run entirely around the band, uniting it with the base plate at

Fig. 135.

every point. The surplus of the base plate material should, with shears and corundum or carborundum-stone, be trimmed off flush with the band, the two now forming a complete cap for the face and sides of the root.

Fitting the Pin.—The next step is the preparation and adjustment of a pin through the cap into the root canal. The canal should be enlarged toward *the palatal* side of the root; this will give more room when we come to grind the tooth, and at the same time secure the greatest attainable strength when the crown is completed.

The base plate of the cap is perforated at a point directly over the opening in the canal. This may be done with a plate punch and enlarged to suit the case with a burr on the dental engine. A pin of platinum wire, number 16 or 17, standard gauge, should now be slightly tapered at the end and passed through the aperture made in the cap and up into the root canal. The end of the pin projecting below the cap may be marked, withdrawn, and bent at a right angle, so that it will point away from the tooth, that is, toward the palatal surface; it may then be waxed in, invested, and soldered with the tooth, or invested and soldered at this stage, and the surplus of pin and solder brought down flush with a file or stone.

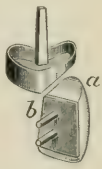
Grinding and Fitting the Tooth.—The cap and pin should be readjusted to the root. A plain-plate tooth,* of suitable form and color, is now ground and fitted to the cap. The labio-cervical edge of the tooth (a, Fig. 136) should be so ground that it will be flush with the edge of

* Many writers advise using cross-pin teeth; it is self evident, however, that in this work straight-pin teeth should be employed and the cross-pins avoided wherever possible, for the same reasons as given under plate work: (1) The position of the pins weakens the body of the tooth. (2) Their position makes the strain upon the tooth greater, as it gives increased leverage between the pins and the cutting edge. (3) There is more liability of cracking the teeth in soldering, on account of so much metal being brought at one point.

the band and meet the margin of the gum. It should also be ground out at the center of the base (b), so as to form a slight space just over the base of the pin.

The tooth is then backed with either thin platinum or gold-plate (gold will give a slight yellow shade to the tooth while platinum will give a bluish tint). The upper edge of the backing, brought down thin with a file or stone, should extend as far as possible under and between the tooth and the cap, so that the solder will more readily flow in and fill what space there may be.

Fig. 136.



Waxing the Tooth in Position.—A perfect joint and the proper length and angle of the tooth having been secured, the pieces, that is, the tooth, cap, and pin, should now be thoroughly dried, then held together in the proper relationship, and secured in this position by running warm adhesive (resin) wax over the palatal portion of the tooth, attaching the backing to the cap. It should then, before the wax gets very hard, be carefully carried to position upon the root, when any correction in the position of the tooth can readily be made. Now apply a drop or two of cold water from the syringe or on a pledget of cotton; this will harden the wax, so that the crown may be removed without changing the position of the tooth upon the cap. It will then be ready to be invested for soldering.

Investing.—A most suitable investment for crown work is marble-dust and plaster, equal parts, with a small quantity of fine asbestos fiber thoroughly incorporated. After the investment has thoroughly set, the wax may be removed and the surface of the backing and cap cleansed by directing upon it a small stream of boiling water. The investment should be cut away so as to

Fig. 137.

expose the sides of the backing and the lower border of the band, as illustrated in Fig. 137, but every portion of the porcelain should be protected.

Soldering and Finishing.—The case should then be at first gently heated up to drive off the moisture, then transferred to the soldering block, when, with the blowpipe, more heat should be applied until the investment and tooth are thoroughly and evenly heated throughout. Gold solder, 18 k., is then cut in small pieces and placed, with a little borax, over the aperture between the backing of the tooth and the cap. The investment being now uniformly heated, the flame from the blowpipe should be directed upon the solder, mostly in the direction indicated in Fig. 137, when, if the entire case has been previously brought to a red heat, the solder will readily melt and flow between the tooth and cap. Additional solder should now be added and melted until the proper contour of the tooth is insured.

The tooth and investment should then be placed in and covered with sand, plaster, or some other suitable substance to keep the heat from radiating too rapidly and thus cracking the tooth. It should be left so covered until it is thoroughly cool. We might add here, that it is well to direct the flame from the blow-pipe into the sand or other material for a moment before placing the tooth in. After the tooth is thoroughly cool, the investment may be broken away, and all oxidation and borax removed *by placing it for a few minutes in the acid bath.* The crown is then ready to be finished and polished. The shaping of the solder can best be done with carborundum stones, followed with hard-rubber discs, and then fine sand-paper or cuttlefish discs, while the final polishing is accomplished with brush and buff-wheels, pumice stone, whiting, and rouge. The completed crown in position is shown in Fig. 138.

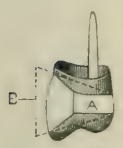
Fig. 138.

THE RICHMOND METHOD APPLIED TO BICUSPID ROOTS.

The capping of the root is similar to that already described; the crown will have greater strength, however, if a portion of the palatal section of the natural crown, when strong enough, is retained, and the band made deep enough to cover it. One pin is all that is usually required, and where there are two distinct canals, the palatal should be used to receive the pin; thus greater strength is secured at the point where it is most needed, and the pin is so located that it will not interfere with the grinding and adjusting of the tooth. The cap and pin being in position, a suitable cuspid tooth or bicuspid facing is then ground, backed, and adjusted to represent the labial aspect, and then properly secured to the cap with adhesive wax. The tooth cap, and pin are then carefully removed, invested, and soldered: after which they are again placed upon the root, and the occluding edge of the tooth is ground clear of the antagonizing teeth at about the angle shown at A, Fig. 139.

Fig. 138.

Fig. 139.



From a suitable die or die-plate (see page 182) the cusps or occluding surface of the tooth is swaged from 22 k. gold plate. These cusps should then be filled in with 20 k. plate or solder. This is done by cutting the gold into small pieces, and placing them, with a little borax, in the depressions of the cusps, all of which is held over a Bunsen burner until the small pieces are melted, when they will flow into these depressions and fill them level full. The surplus is trimmed away, the cusps ground and fitted to the edge of the porcelain, in position to secure proper occlusion (Fig. 139), and secured with wax as shown at A.

A piece of thin, pure gold plate or mica is then adjusted

on each side of the crown (B, Fig. 139), the surfaces of which, if dry and slightly warm, will be held in position temporarily by pressing them gently against the side of the wax. This is all now invested together (Fig. 140).

The long ends of these side pieces, after being invested, hold them in position, as the investment should be cut away so as to expose the sides of the crown as shown at A, Fig. 140. In the process of soldering, after the case has been properly heated, the small pieces of solder and borax are placed in the aperture formed by these sides of gold or mica (the place formerly filled with wax), and the flame from the blowpipe directed cautiously against these exposed sides (A). The solder will then flow, uniting the several parts,

Fig. 140.

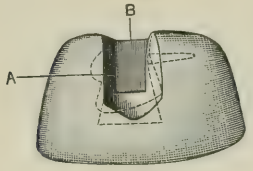


Fig. 141.

when more should be added until the proper contour with perfect continuity of structure is secured. The crown can be made without the gold or mica sides if great care is exercised in flowing the solder. There will be more surplus solder, however, to be finished off.

In finishing, the solder is brought to the contour of a bicuspid tooth with stones and sand-paper discs, when it is ready for the polishing process. The finished crown is represented in place upon the root in Fig. 141.

Other Methods.—There are other methods practised, and though some of them may not be as artistic as the one just described, they are much simpler and quicker. For instance, the palatal cusp may be built up with several pieces of gold plate—previously melted into the form of balls and

flattened out with a hammer. The backing is brought down and closely burnished over the cutting edge of the tooth, which is then waxed in position, tried in the mouth, and invested, and when ready to be soldered, these flattened pieces of gold are laid in position, united, and filled in with 18 k. solder, which is also brought over the backing to the tip of the tooth. This plate and solder are afterward brought to the proper shape and contour with the stones and discs.

Then, again, the palatal portion of the band is extended down so as to nearly touch the antagonizing tooth. This leaves only a comparatively small space to be filled in with solder, which is afterward trimmed and finished to the form of the crown.

Another method is to back the tooth, grind off or bevel the occluding surface, and then joint and adjust the prepared gold cusps; wax them in position, invest, and flow in sufficient 20 k. solder to hold them securely in position, after which the tooth may be ground, adjusted, and soldered to the cap, as has been directed. One advantage of this method is, that different forms and shades of bicuspid facings may be so prepared—with gold occluding surfaces—and kept in stock; and again, in the latter three methods, as may be seen, it is only necessary to invest the cap once after adjusting the tooth.

Gold Shell Crown with Porcelain Facing is probably one of the most satisfactory forms of crown for the bicuspids. The gold crown is made as described on page 180 excepting that the cusps are not filled at this time.

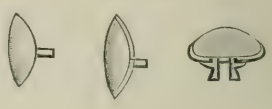
The crown is placed on the root in the mouth, and perfectly adjusted to same and the articulation corrected if need be. With an excavator the face of the crown is now outlined where the porcelain is to appear. That is the gum line and the points of contact with the adjoining teeth

are indicated. Remove the crown and with a small saw revolved by the dental engine saw out the portion indicated. The crown in this condition is represented in a and b, Fig. 142. Bevel the inner edge or seat for the facing with a plug finishing bur or small stone. Select a suitable facing and grind to fit (a, Fig. 143). Back the facing with pure gold, 34 or 36 gauge, punching holes in the backing for

Fig. 142.

a *b* *c*

Fig. 143.



a *b* *c*

the pins, annealing as required and burnishing to conform to tooth, as indicated in b, Fig. 143. With a sharp knife or chisel cut a barb on each of the pins in the facing and press barbs down against the backing to keep it in place until the solder makes a permanent attachment. This is shown in c, Fig. 143. Press the facing into open face of the crown, bind the two together with wire, that portion of the wire covering the porcelain to be covered with asbestos, to prevent discoloration. Flux, and place a little solder on the inside at the union of the backing and the crown and in the cusps; hold the crown over a Bunsen burner (Fig. 144) until the solder flows. The finished crown is shown in Fig. 142, c.

Fig. 144.

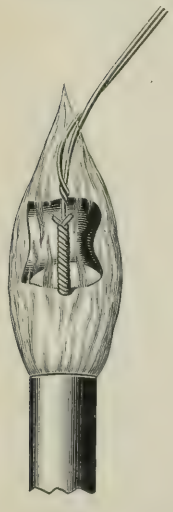
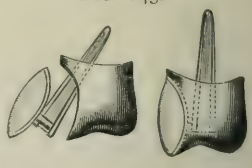


Fig. 145.



If it is desirable to use a pin or post for additional anchorage, bend the pins in the facing suffi-

ciently to clamp the posts, inserting through the open face of the crown, as shown in Fig. 145, solder and finish as before.

THE DOWNIE CROWN.

In this crown we have a combination of the all-porcelain crown with a band or ferrule. The root is prepared and measurement taken as has just been described for the Richmond crown.

Making the Band.—The band is made from platinum, a strip of which of sufficient length and width is soldered with pure gold. The band is now adjusted and fitted to the root, allowing a narrow margin to extend below its end. Remove the band and cut small V-shaped spaces in its lower border, which, when the band is replaced in position, will allow the points to be bent down over the root. Fig. 146 shows the band thus prepared.

Preparing the Tooth.—Select a suitable plain, cross-pin tooth, take square iridio-platinum wire of sufficient size for post, taper one end and flatten the other with a hammer, file notch in each side, and, placing between pins, bend them over as in Fig. 147. If the bite is close, grind pins down to give sufficient room for the body. After fitting the tooth to position, by bending post, if necessary, or grinding base of tooth, dry the root and adjacent parts, and warming a small pellet of sticky wax, place it on end of band, which is in position on the root, and force post through it and press tooth up to position. Now bring wax up against the back of the tooth and see that the articulation is correct. Carefully remove all together by loosening band with hoe-shaped excavator. Remove wax from around post where it has drawn inside of the band. Mix silex and plaster, in the

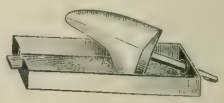
Figs. 146, 147.

proportion of two parts of plaster to three parts silex, and fill the band with the investment, building up slightly around the post. After investment sets, boil out the wax. Fig. 148 shows the tooth with investment in band and wax removed.

Applying the Body.—Back up with porcelain body and put in the furnace and fuse. Add more body, building up over anterior surface of band to conceal it, and fuse again. We now have a finished crown, as shown in Fig. 149.

In baking, the crown is placed in a small tray or slide, as shown in Fig. 150, putting post through a hole in back end of tray, face up. This prevents the tooth being fused

FIG. 148. FIG. 149. FIG. 150.



on to the tray, as it rests only on the back of the band, being held up by the post, and the body not being built up over the posterior part of band.

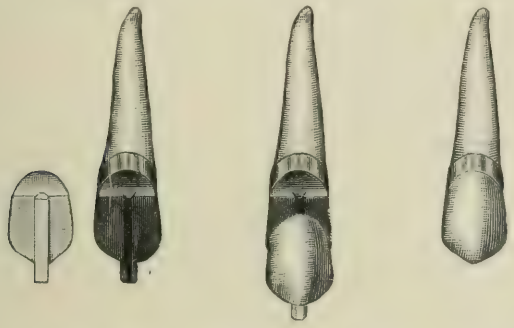
Ordinary teeth for vulcanite work can be used in making this crown if desired. When they are used the post should be soldered between pins with pure gold.

THE MASON CROWN.

It has long been the desire of the profession to overcome the annoyance caused by the breakage of the porcelain facings in crown- and bridge-work. Many efforts have been made to produce detachable facings, but prior to the introduction of the Mason crown none has been designed that could be manufactured and sold to the dentist for his immediate use. Through the efforts of Dr. W. L. Mason,

a system of corresponding dovetail and groove, and a process of manufacturing whereby a porcelain facing is made independent of its backing, has been devised. Figs. 151, 152 and 153 represent the manner of constructing a superior cuspid crown. Fig. 151 shows the root, prepared in the usual way for the reception of a collar crown, with the Mason metallic backing adjusted to same; also the back face of a cuspid facing, showing the dovetail attachment, which is baked in the body of the tooth. Fig. 152 shows the same tooth being adjusted to the backing, while in Fig.

Fig. 151. Fig. 152. Fig. 153.



153 we have the crown complete, the same principle being carried out in any other tooth and in bridge-work.

The tooth, with its dovetail, is fitted to the band by grinding out where necessary. Then the gold backing is waxed to the band, and, after wax is hard, the porcelain is removed from its backing, by taking hold of extended portion of dovetail, and drawn from same. The crown without the porcelain, is now ready to invest for soldering. First the dovetail groove is filled up with Mason's investment material, to keep out the solder, which it will do perfectly, then the piece is invested as usual, letting the plaster come well over the cutting point of backing. It is now ready for soldering, and can be heated up, soldered, and cooled off

as quickly as desired. After removing from investment, the groove should be thoroughly cleansed and dried; also the dovetail in porcelain. Now take some chlora-percha, quite thick, fill up groove, and press porcelain home. Saw off (never cut) the extended portion of metal dovetail and finish as usual. Porcelain can also be cemented on with cement or sulphur. For use as a dummy, articulate to position, remove, and solder "stop" to neck of backing to prevent porcelain from slipping upward; replace on model, join parts with wax, then withdraw the porcelain and invest.

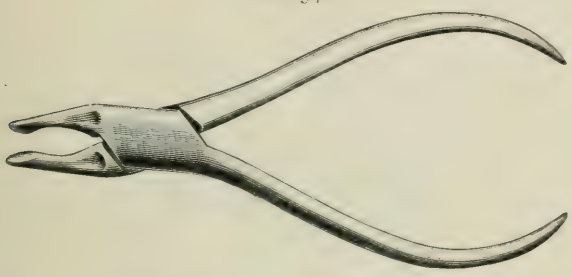
The advantages gained by this method can only be appreciated by practice. The *first* is that we do not, at any time, have to place the teeth under the flame of the blowpipe; *second*, we are not annoyed by the changing of color which takes place in soldering; *third*, a solid backing, without bubbles; *fourth*, the invested piece can be quickly heated, soldered, and cooled; *fifth*, the small amount of solder necessary—just enough to join parts together; *sixth*, saving the porcelain from being etched by borax; *seventh*, we are able to fit a bridge releasing the strain by cutting and resoldering and not have the porcelain interfered with; *eighth*, the most important of all, the amount of time saved to the busy dentist in making repairs, it being accomplished in a few minutes. The above is also applicable to the use of the "Wedge-Lock" tooth in crown and bridge work.

THE ALL-GOLD CROWN, OR CAP.

In the construction of the all-gold crown, the sides of the natural crown and neck of the tooth are brought down to—or a little smaller than—the size of the root. This is best accomplished by the use of diamond discs and small carborundum-stones on the dental engine. From the occluding surface, if any of it remains, a sufficient amount should be ground away, and the edges slightly rounded, to allow the introduction of the gold cusps. The measurement and

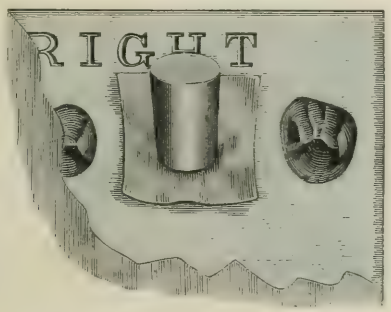
making of the band is the same as described in connection with the Richmond collar crown (see page 167), excepting in the width of the ferrule. This should extend from the root, below the gum-margin, to within a line of the occlusion with the antagonizing teeth. After soldering and

Fig. 154.



adjusting, the band should be shaped and contoured with burnishers and suitable pliers (Fig. 154). The surface of the band to which the cusps are to be attached should then be brought down perfectly smooth and flat with a fine file; readjusted carefully to the root, to make sure that it has not

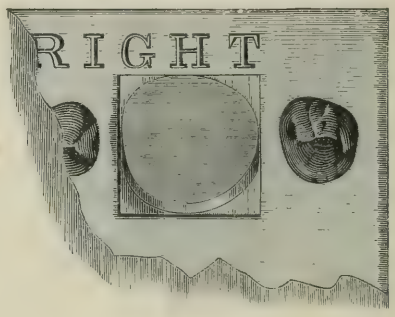
Fig. 155.



been so distorted by the different manipulations that it will not pass readily to place and fit the root perfectly at every point. Finding all correct, the next step is making the cusps.

Making the Cusps, or Occluding Surface.—A number of methods have been put forward for making gold cusps. The two that have proven most satisfactory are the use of separate dies, and by means of the die plate. In the former the gold plate is placed upon a piece of lead and the die carefully driven into it, while in the latter method the plate

Fig. 156.



is laid over the die desired and the hub or small piece of lead is driven down into the depression. This method is shown in Figs. 155, 156 and 157.

Fig. 155 shows a section of the die plate with a piece of gold plate over the upper right first molar, and the lead hub ready to be driven home. Fig. 156 shows the appearance

Fig. 157.

after driving the lead, while in Fig. 157 we have the appearance of the cusps swaged into the gold as well as the lead after they are removed from the die plate.

Reinforcing the Cusps.—After securing a well-defined

occluding surface or cameo for the case in hand, it should be filled with gold plate scraps or solder of a lower carat, with a little borax. This is all held over a Bunsen burner until the small pieces of gold come to the fusing point and settle down into the depressions of the shell. More small pieces should then be added until it is level full. The surplus gold should then be trimmed away, and a file passed several times over the surface of the solder to bring it down perfectly level and smooth. This is all illustrated in Fig. 158.

Before removing the band from its position in the mouth, a small mark should be made with an excavator to indicate the center of the buccal surface, which will serve as a guide

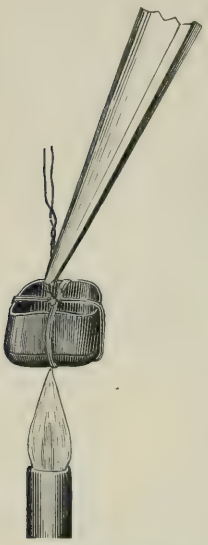
Fig. 158.

for the correct placement of the cusps. By giving the band and the cusps a smooth surface with a fine file, as has been directed, it will be found that an accurate joint between them can readily be secured.

Adjusting and Soldering.—Having carefully noted the line of occlusion and marked the band to indicate the point where the center of the buccal surface of the cusps or crown-plate should be placed and soldered, the two—the band and the crown-plate—should be carefully brought together and secured with a few strands of small binding wire. The joint should now be coated with borax dissolved in water, when it ready for the final soldering. If solder has been used in filling the cusps, no additional solder will be needed at this time, as by simply holding the crown over the flame of a Bunsen burner, as shown in Fig. 159, until the solder is seen to come to the fusing point (when it should be in-

stantly withdrawn), it will all be united perfectly. If, however, gold plate has been used entirely in forming the crown-plate, a small piece of solder will be needed to unite them.

Fig. 159.



The crown is now ready for the finishing processes, which consist in filing or grinding off any projecting edges of the cusp-piece flush with the face of the crown, and smoothing and beveling the free edge of the band or ferrule; the crown should then be adjusted to the root and the occlusion noted. If, as is frequently the case, a little of the gold needs to be removed at one or more points, in order to have a perfect occlusion, it should be done with a small, flat-faced carborundum-stone. The crown should then be removed and polished at the lathe.

Another method is to take a wax or modeling compound impression of the root with three or four of the adjoining teeth, and also of the antagonizing teeth. Secure casts of the same; outline the root to be crowned, clearly on the model and from this secure a metal die. The band is fitted to this die and transferred to the articulated plaster model for contour and final adjustment.

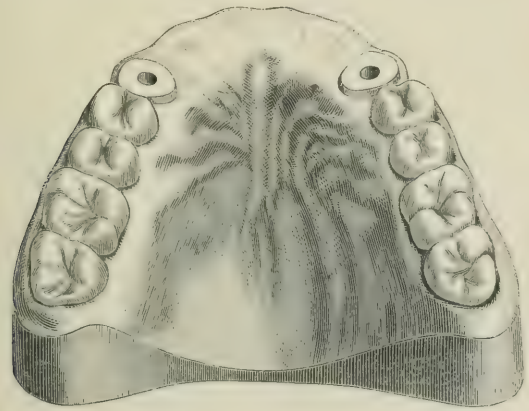
BRIDGE-WORK.

As we have previously written upon this subject (see Richardson's Mechanical Dentistry), bridge-work, to the skilled dentist with experience in crown-work, does not present any great difficulty, inasmuch as crowns are the beginning and the end; it is practically continuous crown-work, though many of the crowns—those filling or bridging

the space where the roots have been removed—have neither collars nor posts. In constructing these teeth, the matter of cleanliness should especially be considered; where it is admissible to allow them to come in contact with the gum-tissue (as in the anterior part of the mouth), only the cervical porcelain tips should touch. The metallic backing and solder should recede, leaving self-cleansing spaces.

Limitations.—For the support of bridge-dentures strong, healthy roots are required, and the width of the space to be spanned must be governed by the size and strength of these

Fig. 160.



points of anchorage. Whether a full upper or lower denture can be supported by four points of attachment depends upon the relative smallness of the jaw, the size and strength of the roots and teeth, and the occlusion, the operator always being governed by the condition of individual cases. For instance: One strong central root will support two teeth, that is, the crown and either the adjoining central or lateral. Two central roots will support the four incisors. Two strong cuspid roots alone, or with the aid of a central root, will support the six anterior teeth. A cuspid root and a strong, healthy second or third molar on the same side will

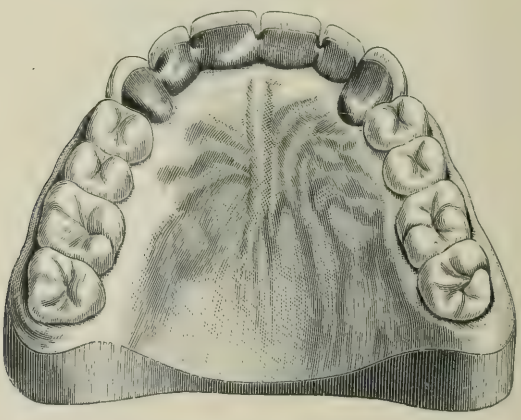
support the intervening teeth. One molar or bicuspid on one side, and a bicuspid or molar on the other, with the central roots, will support a bridge between them. One right and one left molar, with the assistance of the two cus-

FIG. 161.

pid roots, when the conditions are favorable, as spoken of above, will support a bridge comprising the entire arch.

It should be remembered that the preparation of the teeth and roots for the support of a bridge is the same as has been described for crown-work, except that the trimming of the sides and the drilling of the root-canals, should be, as far

FIG. 162.



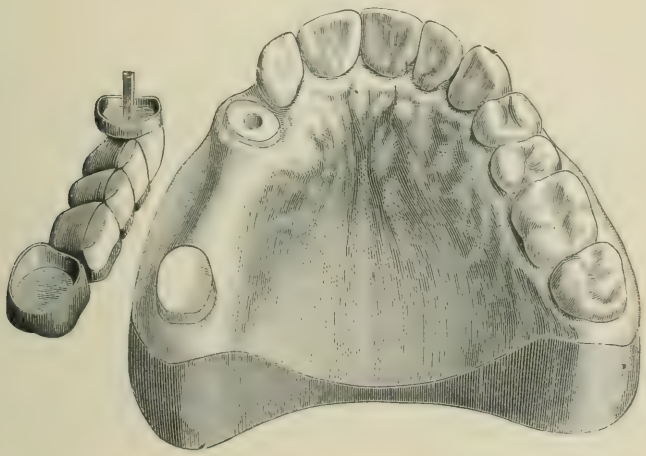
as possible, *in parallel lines,* so that in the adjustment of the finished piece the crowns will move readily to their place.

The simplest and no doubt the most practical method of bridge-work is that first described by Dr. J. L. Williams.

Two or three typical cases will be described which will be sufficient to present the subject.

Bridging from Cuspid to Cuspid.—Fig. 160 shows a model of a mouth in which the superior laterals and centrals had been extracted. The cuspid teeth were badly decayed, with exposure of the pulps. The first step is the removal of these pulps. The crowns are then fitted as already described and placed in position. An impression is taken in plaster, the crowns remaining embedded on its removal. The impression is varnished and oiled, and a model of

Fig. 163.



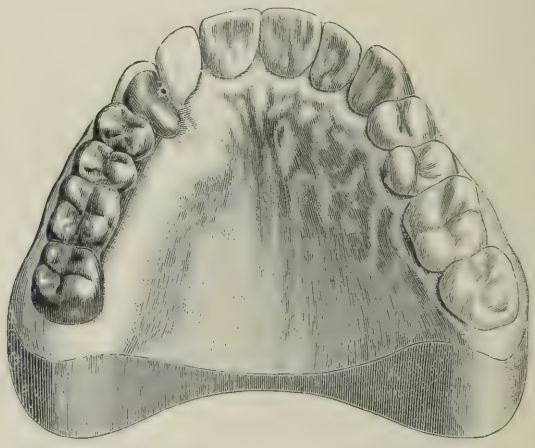
investing material poured. After this has hardened the impression is carefully cut away, and we have a model of the mouth with the crowns in position. A "bite" is taken and the articulation secured in the usual manner. The remaining crowns, having been backed, are fitted, and the face of the work embedded in investing material.

The whole piece is now united at the back by soldering, and when finished presents the appearance shown at Fig. 161.

Fig. 162 shows a model of the mouth after the bridge has been cemented in place.

A Lateral Bridge.—Fig. 163 is an illustration of a piece of this work for which there is a very frequent demand. It is for supplying the loss of the first molar and bicuspids. If, as is frequently the case, there is extensive decay in the cuspid, it will be best to excise the remaining portion of the tooth and construct an artificial crown as shown in the illustration. A gold cap is then made for the second molar. If this tooth is decayed it will only be necessary to remove

Fig. 164.



the decay, and the cement which is used for setting the bridge will make the most perfect filling material beneath the gold cap. The intervening molar and bicuspid crowns are made in the following manner: the porcelain faces are backed with gold or platinum and the tips ground squarely off. Zinc dies, an assortment of which should be made from the grinding surfaces of molars and bicuspids, or the die plate which has been described in another place, are used for swaging from pure gold, a tip or cusps for the protection

of the porcelain facing; for without this protection the porcelain would be almost certain to be broken. The concave surface of these tips is filled as described under crown-work with solder of a little lower carat. This surface is then ground smooth and fitted to the squared surface of the porcelain facing and waxed in position. Triangular pieces of platinum are then cut of the proper size to fit the sides of the tooth, waxed in position, and the whole invested, leaving the back open, which is filled with 18 k. solder or coin-gold.

These teeth are then fitted into position in the bridge, as previously described.

Fig. 164 shows the completed work in the mouth.

Where only one molar or bicuspid is lost, sufficient support may be gained by the cap, which is made to pass over the adjoining molar. If the first molar and second bicuspid are lost, the anterior end of the bridge may receive sufficient support from a strong spur (Fig. 165), which may rest in a cavity in the first bicuspid, and around which a filling is placed.

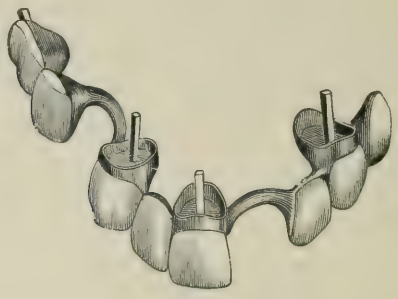
Fig. 165.

Fig. 166 illustrates a device for obviating the necessity for removing the crowns of natural teeth in preparing the mouth for bridge-work. Crowns are fitted in the mouth to the points of attachment in the usual manner. An impression is taken, bringing the crowns away in their proper positions. From this the cast or model is obtained. Heavy bands of half-round gold or platinum wire are now fitted around the necks of the natural teeth on their lingual surfaces. These bands, being waxed in position, serve to connect the different parts of the bridge, uniting them in one piece without the loss of any of the natural crowns. This will be found a highly satisfactory method of inserting both small and more extensive bridges. Fig. 167 shows

the mouth as presented for which the bridge was constructed. Fig. 168 shows the piece in position.

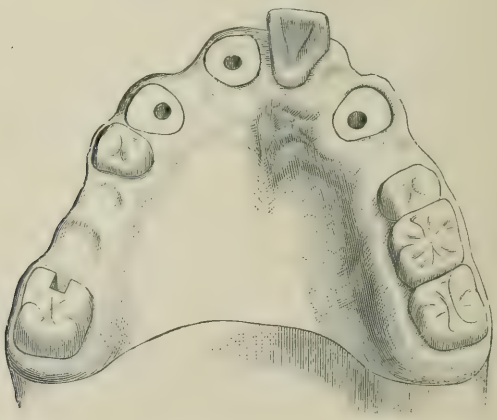
A case, which is a type of a class of frequent occurrence,

Fig. 166.



is shown in Fig. 169. Alternate molars and bicuspids in the upper and lower jaws are lost, until the occlusion is somewhat changed, and the force of mastication is grad-

Fig. 167.



ually brought upon the front teeth. Rapid wearing of these teeth results. The cases are among the most difficult that the operator is called upon to treat by the ordinary methods.

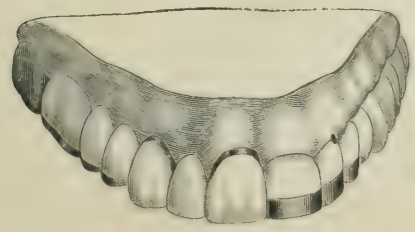
In the case herewith illustrated, the lower bicuspids, with a molar on one side, were in good condition, but the loss of the upper bicuspids and molars made them useless. As

Fig. 168.

Fig. 169.

Fig. 170.

Fig. 171.

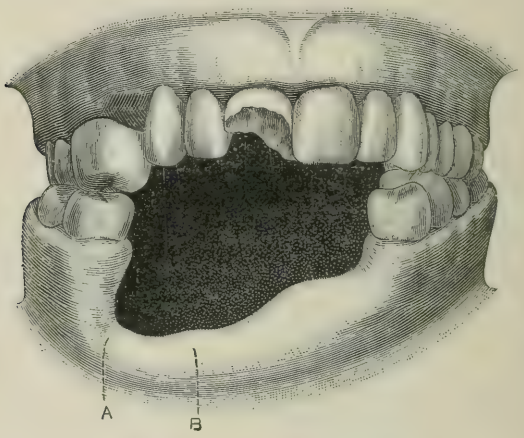


usually happens, the upper incisors had suffered most. The lower incisors were restored by capping them with cohesive foil. The bridge shown in Fig. 170 was constructed for the right side of the upper jaw, while the teeth on the left side were restored by contour work, as shown in Fig. 171.

The superiority of the condition of the patient's mouth, which resulted from this work, over anything which could have been accomplished by plate-work may readily be appreciated.

A case showing to what extreme the dentist may be called upon for services, and to what extent bridge-work

Fig. 172.



may play a part in restoration, is illustrated in an operation by Dr. J. D. Patterson, of Kansas City.

The patient, a member of the United States Cavalry, was struck upon the lower jaw with a ball from a Winchester rifle. The part of the jaw from the second bicuspid upon the left side to the second molar on the right was badly shattered, and at a point in the region of the right cuspid for the space of about six lines, the bone was entirely gone (Fig. 172, A, B), leaving the remaining posterior parts

freely movable. This loose bone and the teeth had been removed, and the case had been in a surgeon's hands for six weeks, when he was brought to Dr. Patterson presenting the following condition.

The outside wounds had healed with considerable cicatricial tissue; the left fragment of the maxilla was easily movable, and an abscess was discharging freely upon the face opposite the loose end with another abscess opening under the chin; the left side of the jaw was much firmer than the right, but had healed far inside—about a half-inch from the normal position. There was still considerable swelling, and small spiculæ of bone frequently made their way to the surface.

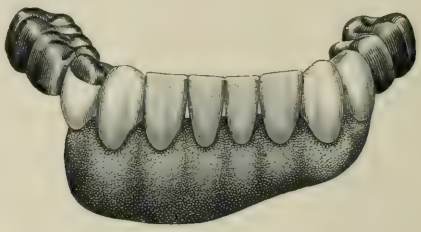
The first treatment instituted, as described by Dr. Patterson, is as follows: "I found that a bridge-splint placed upon the parts as presented would result in retaining the incorrect position of the left side, and that pressure brought to bear or force the pieces apart would result in still greater deformity, because the more easily movable right fragment would give way, leaving the left in its former position. The first step then was, if possible, to remedy the distorted position of the left side. I proceeded as follows: I banded the first lower molar upon the right side and also the first upper molar upon the same side, attaching lugs to the bands for the reception of a screw, and firmly screwed them together. I then placed a jack-screw upon these molars on the palatal side and against the molar on the left side, and forced that side into its correct position, which had been determined by models beforehand. I then banded the upper and lower teeth upon this side as upon the other, and screwed them firmly together.

"I then dismissed the patient for ten weeks, the intention being to overcome the growth of cicatricial tissue which forced the left side against the tongue. I believed the

abscesses were caused by the movement of the loose ends upon the soft tissue, and the result proved that this surmise was correct, as they soon healed after the parts were secured firmly to the upper jaw.

"At the end of three months the patient returned. He reported himself as very comfortable, save only that he was limited entirely to soft foods. On the removal of the bands

FIG. 173.



the left side, after two or three days, swerved slightly inward and there remained, not quite but nearly in correct position. I then proceeded to make the splint-bridge shown in the accompanying illustration (Fig. 173)."

DENTAL METALLURGY.

Metallurgy may be defined as the operation of obtaining metals from their ores, or combinations with non-metallic elements, their physical properties or special characteristics, and the methods of manipulation.

Metals are elementary substances, and with the exception of mercury, are solid at ordinary temperatures. They have many physical properties which are so pronounced as to place them in a class by themselves.

Physical Properties of Metals.—Some of the most important characteristics are their molecular structure, density, malleability, ductility, tenacity, toughness, hardness, brittleness, elasticity, conductivity, and fusibility.

Molecular Structure.—Like all other elements, metals are composed of atoms grouped in molecules, and the presence of any other element or extraneous force altering the relation of the atoms in the molecules modifies the physical properties of the metal.

Density.—The density of a metal is dependent upon the intimacy of the contact between the molecules. This property is therefore influenced by the temperature of casting, the rate of cooling, the mechanical treatment, and the purity of the metal.

Malleability.—The malleability of metals is the property in virtue of which their form may be changed by hammering or by rolling.

Ductility.—This is the property in virtue of which metals may be drawn into wire.

Tenacity.—The property in virtue of which metals resist attempts to pull their particles asunder. This embraces adhesion and cohesion.

Adhesion is the force which unites molecules of different kinds.

Cohesion is the force which unites molecules of the same kind.

Toughness.—The toughness of a metal is the property of resisting the separation of their molecules after the limit of elasticity has been passed.

Hardness.—By this term we refer to the resistance offered by the molecules of substances to their separation by the penetrating action of another substance.

Brittleness.—The property in virtue of which the molecules of certain bodies are easily broken apart.

Crystalline Character.—A substance is said to be *crystalline* when the molecules arrange themselves in a definite and regular manner. These forms are crystals and when this action has taken place the substance is said to be crystallized.

Elasticity.—The power certain bodies possess of resuming their original form or volume size after the removal of an external force, which has changed that form or volume.

Conductivity.—The property in virtue of which metals, to a greater or less degree, transmit or conduct the electric current or the impressions of heat and cold.

Fusibility.—The property in virtue of which metals upon the application of certain degrees of heat pass from a solid to the liquid state. On account of the difficulty experienced in determining high temperatures, only those that fuse or melt at temperatures below 2000 F. can be ascertained with absolute accuracy. Those above this point must be taken only as an approximation.

Capacity for Heat.*—Equal weights of different metals require different amounts of heat to raise them from the same to a higher given temperature. The amount of heat necessary to raise one part by weight of water from 0 C. to 1 C. being 1, the amount of heat required respectively to raise the same weight of the following metals from 0 C. to 1 C. will be as follows:

SPECIFIC HEAT OF METALS.†

Aluminum	0.2143	Tin	0.0562
Iron	0.1138	Antimony	0.0508
Nickel	0.1086	Mercury	0.0333
Zinc	0.0955	Platinum	0.0324
Copper	0.0952	Gold	0.0324
Palladium	0.0593	Lead	0.0314
Silver	0.0570	Bismuth	0.0308
Cadmium	0.0567		

It will be seen from the above table that the capacity for heat of the several metals is very variable. If small balls of equal weights of different metals are exposed for the same length of time to exactly the same temperature and then withdrawn simultaneously and placed upon a thin cake of wax, it will be observed that the metals having the greatest capacity for heat such as iron, will "melt" their way through the wax much more rapidly than those having a smaller capacity for heat.

Expansion by Heat.—Metals expand when heated, though not uniformly. The degree of expansion, within certain limits, is generally proportionate to the increase of heat. Expansion can be considered from three standpoints: *linear expansion*, or expansion in one direction, *superficial*, or expansions in two dimensions, and *cubical* or expansion in three dimensions. This property is taken advantage of in adopting metals for certain purposes. Zinc, for instance,

* Smith's Dental Metallurgy.

† Regnault, "Cours Élémentaire."

possessing a high degree of expansibility, will upon cooling be smaller than the plaster model from which the mold was made. It is, therefore, an admirable metal for making dies for swaging metal plates. The fact that plaster of paris expands in setting is well known, and the contraction of zinc upon cooling, in this connection, at least, compensates for this expansion.

Change of Volume on Solidification.—The change of volume when passing from the fluid to the solid state, above referred to, is common with all metals with the exception of bismuth, which expands. This change of volume is of practical importance, as indicated in the making of dies with zinc.

Galvanic Action.*—When two dissimilar metals are immersed in a fluid, the chemical action of which is more energetic on one than on the other and then brought into contact a feeble electric current is produced known as galvanic action. This galvanic action is sometimes experienced when different metals are in contact in the mouth. The amount of action is infinitesimal in healthy states of saliva; but in acid, or other unhealthy condition a very efficient exciting fluid is in constant action.

Effects of Exposure in the Mouth.—Some metals, such as silver, copper, and cadmium, are readily acted upon when exposed in the mouth. This is due principally to the presence of sulphuretted hydrogen, and the affinity these metals have for sulphur. Gold and platinum are not acted upon to any appreciable extent as they are practically non-oxidizable and have no affinity for sulphur.

Welding.—This is the property possessed by metals when in a plastic state (the stage between the molten and the solid state), of being joined together by the cohesion of the molecules, induced by hammering or other external force.

* Smith's Dental Metallurgy.

Atomic Weight.—The weight of an atom of an element, as compared with the weight of an atom of hydrogen.

Alloys.—The mechanical properties of metals are very much changed by associating them with each other in the form of an alloy.* They are usually *harder, more* brittle, *less* ductile and tenacious, their power for conducting heat and electricity being greatly reduced. Their fusing point is usually lowered, that is, the alloy melts more readily than that of the least fusible constituent metal, and oftentimes lower than that of any of the constituent metals. This will be considered more fully in another place.

Noble and Base Metals.—It is customary in studying metals to classify them into *noble* and base metals.

The first, or *noble* metals are those having a very feeble affinity for oxygen, and are capable of being readily separated from any combinations with oxygen by the application of moderate heat. This lack of affinity for oxygen renders them incapable of rusting or tarnishing by oxidation in the air.

The second class or *base* metals, are those which lose their metallic luster, oxidize, or rust in the air at ordinary temperatures. The term "noble" is therefore applicable to gold, silver, platinum and the rare metals found associated with platinum. Mercury is also included as one of the noble metals.

Native Metals.—A few of the metals are sometimes found native, that is, in a free or uncombined state. Usually, however, they are found in combination with non-metallic elements, such as oxygen, sulphur, etc.; these are known as ores.

Ores.—As has been indicated, ores are metals found in nature combined with non-metallic elements forming a

* An alloy is a mixture or compound of two or more metals, usually formed by fusing the metals together. See chapter upon the subject.

series of bodies known as *metalliferous minerals.* The art of extracting metals from their ores is an important part of metallurgy.

Methods of Extracting.—The process of extracting metals from their ores may be divided into two classes, known as the dry and the wet methods.

The first, or dry method is where ores are treated in furnaces at high temperatures. This operation is usually referred to as *smelting.* The second or wet method is where, after the ore has been crushed and converted into a readily soluble compound, the metal is extracted by a suitable solvent.

Furnaces.—There are various forms of furnaces employed in smelting. (1) The *blast furnace,* usually a vertical chamber or stack, the ore and fuels being introduced at the top, the molten metal being drawn off at intervals at the base. (2) A horizontal furnace known as a reverberatory furnace. This consists of three distinct parts,—a fireplace at one end, a stack or chimney at the other, and a bed between them on which the ore is heated. It is owing to the reverberation of the flame on the ore spread over the bed that the furnace takes its name. (3) Muffle and crucible furnaces; these, however, are for lighter metallurgical work in the laboratory,—the melting of metals, and alloys, and for assaying.

In the following chapters the metals will be classified and considered according to their usefulness in the dental laboratory, gold being the first, as it is in many respects the chief among metals, and to the dental practitioner of the greatest importance.

GOLD.

Symbol, Au (Aurum). *Atomic weight,* 196.2.

Occurrence.—Gold is one of the few metals found in the metallic state, the native metal being found in some of the oldest rock, and usually contains more or less silver, and sometimes associated with it in small quantities. The purest specimens of native gold contain from 95 to 99 per cent. of gold.

Physical Properties.—The individuality of gold among metals is strongly marked, owing to its color, orange-red or yellow, its extreme malleability and ductility (surpassing all other metals), its perfect resistance to the action of the air (non-oxidizable), conducting power for heat and electricity, high fusing point, resistance to simple acids (soluble only in aqua regia), its rarity and consequent intrinsic value.

The fusing point of gold is 2016° F. It fuses with considerable expansion and on cooling contracts more than any other metal.

Properties of Particular Alloys of Gold.—In the dental laboratory gold is liable to become contaminated with other metals which are highly destructive in their influence to the properties which adapt gold to the various needs of the mechanical operator. Care should be taken to prevent their admixture with the gold scraps or filings that are to be reconverted into proper form for use. The effect of alloying certain metals with gold is as follows:—

Zinc with gold forms a brittle alloy, and when combined in equal proportions is exceedingly hard, white, and brittle.

Lead renders gold intractable (refractory; not easily managed).

Tin, bismuth, and arsenic also render gold intractable.

Copper hardens and toughens gold without practically

impairing its malleability; it gives a deeper color and renders it capable of receiving a richer polish.

Silver renders gold more fusible, increases hardness, does not materially affect malleability, and gives a lighter color.

Platinum in small proportions renders gold harder and more elastic without impairing malleability. Makes color pale and dull. Excess of platinum renders the alloy infusible in the blast furnace.

Mercury dissolves gold and combines with it at all temperatures.

PREPARING ALLOYS OF GOLD FOR DENTAL PURPOSES.

Gold in its pure state is rarely employed by the dentist in laboratory processes on account of its softness and flexibility; it is, therefore, usually alloyed with such metals as impart to it—without practically impairing its malleability, pliancy or purity—the degree of hardness, strength, and elasticity necessary to resist the wear and strain to which an artificial piece constructed from it is unavoidably exposed in the mouth.

Reducing Metals.—The metals with which gold is usually combined are copper and silver. It is sometimes reduced with silver alone, many regarding the introduction of copper into the alloy as objectionable as plate derived from it is supposed to be more readily tarnished and to communicate to the mouth a disagreeable metallic taste. The small proportion of copper usually employed in forming gold plate, however, is not likely to produce in any objectionable degree the consequences complained of, unless the fluids of the mouth are greatly perverted. If gold coin is used in the formation of plate, it may be sufficient to add silver alone, inasmuch as copper is already present; though, usually, additional quantities of the latter metal are added.

Required Fineness of Gold Plate.—Alloys of gold to be permanently worn in the mouth should be of such purity as will most certainly, under all the contingencies of health and disease, resist any chemical changes that would tend to compromise either the comfort or health of the patient. It should not, therefore, as a general thing, be of a less standard of fineness than from eighteen to twenty carats. It may exceed this degree of purity in some cases (as for lower dentures), but will rarely or never, unless alloyed with platinum, admit of being used of a higher carat than the present American coin, which is 21.6 carats fine.

Formulas for Gold Plate used as a Base for Artificial Dentures.—Any of the following formulas may be employed in the formation of gold plate to be used as a base or support for artificial dentures. The relative proportions of the alloying components may be varied to suit the peculiar views or necessities of the manipulator:—

GOLD PLATE EIGHTEEN CARATS FINE.

Formula No. 1.	*Formula No. 2.*
18 dwts. pure gold,	20 dwts. gold coin,
4 dwts. fine copper,	2 dwts. fine copper,
2 dwts. fine silver.	2 dwts. fine silver.

GOLD PLATE NINETEEN CARATS FINE.

Formula No. 3.	*Formula No. 4.*
19 dwts. pure gold,	20 dwts. gold coin,
3 dwts. copper,	25 grs. copper,
2 dwts. silver.	40 + grs. silver.

GOLD PLATE TWENTY CARATS FINE.

Formula No. 5.	*Formula No. 6.*
20 dwts. pure gold,	20 dwts. gold coin,
2 dwts. copper,	18 grs. copper,
2 dwts. silver.	20 + grs. silver.

GOLD PLATE TWENTY-TWO CARATS FINE.

For Crown- and Bridge-Work.

Formula No. 7.

22 dwts. pure gold,
1 dwt. fine copper,
18 grs. silver,
6 grs. platinum.

Formulas for Gold Plate used for Clasps, Wire, Backings, etc.—Gold used in the formation of clasps, backings, etc., is improved for these purposes by the addition of sufficient platinum to render it firmer and more elastic than the alloys ordinarily employed in the formation of plate as a base. The advantages of this elastic property, in its application to the purposes under consideration, are, that clasps formed from such alloys will adapt themselves more accurately to the teeth, as, when partially spread apart on being forced over the crowns, they will spring together again and accurately embrace the more contracted portions. In the form of stays or backings, additional strength being imparted, a less amount of substance will be required; the elasticity of these supports, also, will not only lessen the chances of accident to the teeth themselves in mastication and otherwise, but preserve their proper position when temporarily disturbed by any of the forces applied to them.

Formula No. 1.	*Formula No. 2.*
20 dwts. pure gold,	20 dwts. gold coin,
2 dwts. fine copper,	8 grs. fine copper,
1 dwt. fine silver,	10 grs. silver,
1 dwt. platinum.	20 grs. platinum.

The alloy derived from either of these formulas will be twenty carats fine.

Gold Solders.—Solders are a class of alloys by means of which the several pieces of the same or of different metals are united to each other. They should be more fusible than the metals to be united, and should consist of such components as possess a strong affinity for the substances to be joined.

When zinc or brass enters into the composition of solders, these metals should be added after the other constituents are entirely melted, and just before the molten mass is cool enough to commence to solidify. The alloy should then be

well stirred with a platinum rod and poured into the ingot mould immediately.

Formula No. 1 of the following recipes is a fraction over fifteen carats fine; No. 2 furnishes a solder eighteen carats fine; and No. 3 a solder twenty carats fine, for crown- and bridge-work.

Formula No. 1.	*Formula No. 2.*	
6 dwts. gold coin,	Gold coin,	30 parts.
30 grs. silver,	Silver,	4 "
20 grs. copper,	Copper,	1 "
10 grs. brass.	Brass,	1 "

Formula No. 3.

Pure gold,	5 dwt.
" copper,	6 grs.
" silver,	12 "
Spelter solder,	6 "

Method of Ascertaining the Carat of any given Alloy.* —The proportion may be expressed as follows:—

"As the weight of the alloyed mass is to the weight of gold it contains, so is 24 to the standard sought. Take, for example, Harris's No. 3 gold solder:—

Pure gold,	6 parts.
" silver,	2 "
" copper,	1 "
Total,	9 "

"The total proportion would be expressed thus: —

9:6::24:16.

"From this any one can deduce the following:—

"RULE.—Multiply 24 by the weight of gold in the alloyed mass and divide the product by the weight of the mass; the quotient is the carat sought.

"In the above example 24 multiplied by 6, the quantity

* From an article on "Alloying of Gold," by Prof. Watt.

of gold gives 144, which, divided by 9, the weight of the whole mass, gives 16. Hence, an alloy prepared as above is 16 carats fine."

To Reduce Gold to a Required Carat.—The proportion may be expressed as follows:—

"As the required carat is 24, so is the weight of the gold used to the weight of the alloyed mass when reduced. The weight of gold subtracted from this gives the quantity of alloy to be added.

"For example, reduce 6 ounces of pure gold to 16 carats.

"The statement is expressed thus:—

16 : 24 : : 6 : 9.

"Six subtracted from 9 leaves 3, which is the quantity of alloy to be added. From this is deduced the following:—

"Rule.—Multiply 24 by the weight of pure gold used, and divide the product by the required carat. The quotient is the weight of the mass when reduced, from which subtract the weight of the gold used, and the remainder is the weight of alloy to be added."

To Raise Gold to a Higher Carat.—This may be done by adding pure gold or a gold alloy finer than that required. The principle of the rule may be set forth in the following general expression:—

"As the alloy in the required carat is to the alloy in the given carat, so is the weight of the alloyed gold used to the weight of the reduced alloy required. The principle may be practically applied by the following:—

"Rule.—Multiply the weight of the alloyed gold used by the number representing the proportion of alloy in the given carat, and divide the product by that representing the proportion of alloy in the required carat; the quotient is the weight of the mass when reduced to the required carat by adding fine gold.

"To illustrate this, take the following example:—

"Raise 1 pennyweight of 16-carat gold to 18 carats.

"The numbers representing the proportions of alloy in this example are found by respectively subtracting 18 and 16 from 24. The statement is, therefore—

$$6:8::1:1\tfrac{1}{3}.$$

from which it follows that to raise 1 pennyweight of 16 carat gold to 18 carats, there must be one-third of a pennyweight of pure gold added to it.

"But suppose that, instead of pure gold, we wish to effect the change by adding 22-carat gold. The numbers, then, respectively representing the proportions of the alloy would be found by subtracting, in the above example, 16 and 18 from 22, and the statement would be—

$$4:6::1:1\tfrac{1}{2}.$$

"It follows, then, that to each pennyweight of 16-carat gold a half pennyweight of 22-carat gold must be added to bring it to 18 carats."

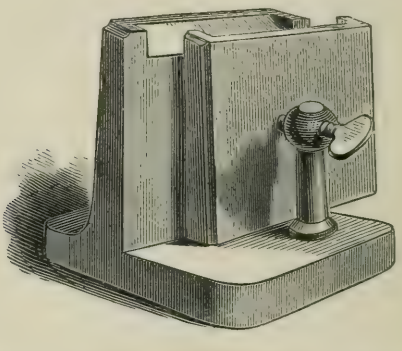
CONVERTING GOLD ALLOYS INTO THE REQUIRED FORMS FOR DENTAL PURPOSES.

Procuring an Ingot.—The metal to be molded in the form of ingot is put into a clean crucible lined on the inside with borax, and placed in the furnace. As soon as the metals are fused, the crucible should be removed and the contents poured quickly but carefully into the ingot-molds; the latter being conveniently near the furnace, as the molten metals soon become chilled on exposure to the open air. Before pouring, the molds, if made of iron, should be moderately heated and oiled, or coated with lamp smoke by holding their inner surfaces over the flame of an oil lamp or gas-jet.

Ingot-molds.—Various substances are used for the construction of ingot molds, but those in most common use are made of iron, and, for gold, are generally about two inches square and from $\frac{1}{8}$ to $\frac{1}{6}$ of an inch thick (Fig. 174). They should be slightly concave on their inner surfaces, to compensate for the greater shrinkage of the gold in the center than at the margins of the ingot.

Soapstone is sometimes employed for the same purpose,

Fig. 174.



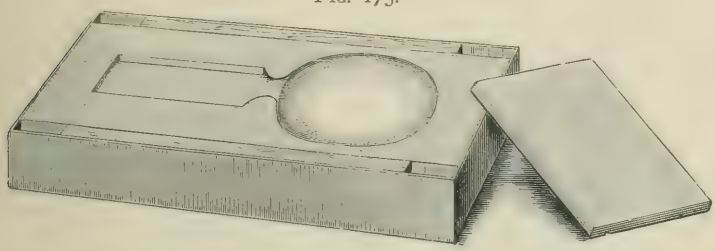
and is preferred by some. Molds made from this substance should also be warmed and oiled before pouring the metals. Molds are also made from charcoal, which is highly recommended for the purpose, though it requires to be frequently renewed.

Charcoal Ingot-molds may be very easily and quickly made. Select a close-grained compact piece of charcoal of suitable size, cut through it with a saw, and then rub the divided surfaces together until perfect coaptation is secured. The required size and shape of the mold is then cut out in one section of the block; the two pieces are then secured in place by binding with wire, or with the use of clamps.

Asbestos Molds.—Comparatively inexpensive, and at the same time more convenient and durable contrivances designed for the same purpose, combining both crucible and

mold, and embracing the special advantages claimed for charcoal, may be obtained at the dental depots. One of the simplest forms of this kind is the asbestos melting and ingot block shown in Fig. 175. When in use, place a piece of charcoal over the bowl-shaped portion of the ingot block, as it facilitates heating the metal. The small asbestos slab being placed in position to complete the mold, and retained in place by clamping, the metal, when sufficiently fused, is poured into the mold by tipping the block. The bowl or crucible has a thin coating of whiting, to prevent borax or

Fig. 175.



other flux from adhering. Should this occur, however, rub a little moist whiting in the bowl. The sides of the block are encased in strips of wood, to protect the hands from heat.

Carbon Molds.—A very ingenious, convenient, and useful apparatus, combining crucible and ingot-mold, by the use of which ingots of gold, silver, etc., may be quickly obtained without the use of a furnace, is shown in Fig. 176. The crucible is of molded carbon, and is supported in position by an iron side-plate. A clamp holds crucible and ingot-mold in position, swiveling on a cast-iron stand.

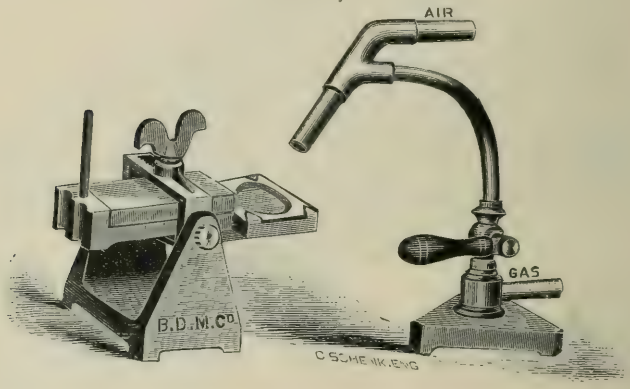
The metal to be melted is placed in the crucible, and the flame of the blowpipe directed on it until it is perfectly fused. The waste heat serves to make the ingot-mold hot, and the whole is tilted over by means of the upright handle at the

back of the mold. With this simple instrument, a sound ingot may be obtained at any time in a very few minutes.

Aside from the greater convenience and cleanliness, as compared with the older method in which draft-furnace heat is used, there is great economy of time in the use of the last-named appliance combining crucible and mold, since an ingot may be thus obtained, with the use of the bellows blowpipe, in from two to three minutes. It is suitable for melting from two to four ounces of gold or silver.

It not infrequently happens that, at the first pouring, the

Fig. 176.



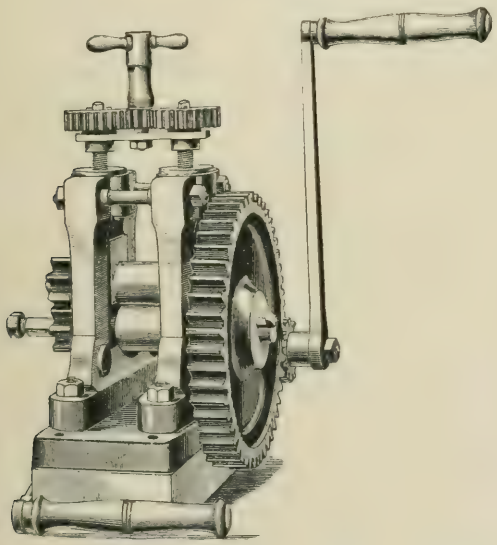
metals arrange themselves in the ingot in accordance with the density of the several components, those of greater specific gravity passing to the bottom, and the lighter metals remaining above. Whenever this occurs, the ingot must be broken into pieces and remelted; this should be repeated, if necessary, until the alloy assumes a perfectly homogeneous appearance. It should then be annealed in hot ashes, which softens the gold and removes the adhering grease.

Forging.—Before laminating, the ingot should be reduced somewhat in thickness by placing it on an even-faced anvil or other equally smooth and resistant surface, and subjecting

it to repeated blows with a heavy hammer. It should be frequently annealed, and the process of forging continued, alternately hammering and annealing, until the ingot is reduced one-half or more in thickness.

Laminating or Rolling.—The reduced ingot, well annealed, is next rolled or spread out into a sheet of greater or less thinness by passing it repeatedly between two strong, highly-polished cylindrical steel rollers. The mills used for the purpose are variously constructed, the plainest forms being very simple in their mechanism, while others, or

Fig. 177.



geared mills, are more complicated, and are constructed with a view to a greater augmentation of power, precision, and certainty of action. Fig. 177 illustrates such a mill.

The rollers should first be adjusted equidistant at both ends, and this uniformity, as they are approximated from time to time, should be preserved throughout. At every passage of the gold bar between the rollers, the distance

between the latter should be diminished, care being taken that the approximation be insufficient to clog or impede the free action of the mills. The gold, which, in time, becomes hard and brittle, and liable to crack in the mills, should be frequently and well annealed by bringing it to a full red heat; this restores the pliancy of the metal and facilitates the operation in the press.

When the ingot has been extended in one direction as far as may be desired, it should always be reannealed before turning it in the mills; a neglect of this precaution will seriously interfere with the working of the gold by twisting or doubling the plate upon itself; and in some instances, provided the gold has not been well annealed throughout the operation, or is in any considerable degree unmalleable, the plate will be torn across and rendered unfit for use.

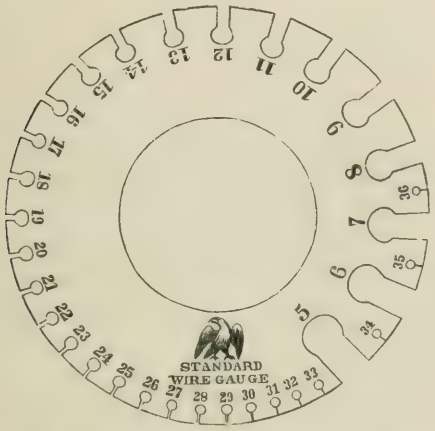
A thin or retreating edge may be given to the plate at any desired point or points by passing such portions part way between the rollers and withdrawing; repeating this, with the rollers brought a little nearer to each other every time the plate is introduced between them, and decreasing the distance the plate passes each time, until it is reduced to as thin an edge as may be desired.

Standard Gage Plate.—The degree of reduced thickness obtained by rolling is determined by what is called a *gage plate* (Fig. 178). This instrument is usually circular or oblong in form, and is marked at intervals on its edge by cross-cut grooves, or fissures, which successively diminish in size and are indexed by numbers ranging from 5 to 36. The sizes of the groove diminish with the ascending numbers. During the operation of rolling, the plates should be tested, from time to time, by the gage, to determine when it has undergone sufficient attenuation.

Thickness of Gold Plate Required as a Base for Artificial Dentures.—In prescribing the thickness of plate proper for

the purpose indicated, no estimate can be given that will apply to all cases. Usually, however, plate for *entire upper dentures should correspond in thickness with number 26 of the gage plate; for the lower jaw, number 24 may be used;* while for partial upper pieces, an intermediate number may

FIG. 178.



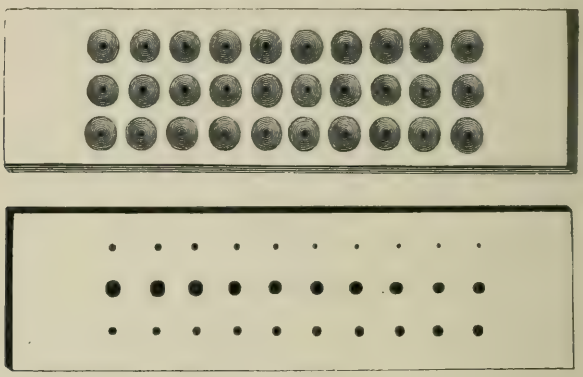
be chosen, unless atmospheric pressure-plates are used, when the number recommended for full upper sets may be employed.

Thickness of Plate for Clasps, Backings, etc.—Plate for these purposes should usually correspond with number 22 of the gage; a less amount of substance may be used, however, when the alloy has incorporated with it a small proportion of platinum.

Reduction of Gold Solders into Proper Form for Use. — The method of converting gold solders into the form of plate does not differ from that already described in the manufacture of plate as a base, except that when zinc or brass is used, the latter should be added after the other constituents are completely fused, and then instantly poured, to prevent undue wasting of the base metals by a too protracted heat.

The solder should be reduced to plate somewhat thinner than that used for upper dentures, about 28 of the gage plate. It is customary sometimes to roll the solder into very thin ribbons, but this is objectionable for the reason that a greater amount of the alloying metals, being exposed in a given surface to the action of the heat in soldering, are burnt out or oxidized, which interrupts the flow and weakens the attachment between the solder and plate.

FIG. 179.



Method of Obtaining Gold Wire.—To convert gold or its alloys into the form of wire, the operator should be provided with a draw-plate, a vise, and a pair of flat-nosed pliers. A draw-plate (Fig. 179) is an oblong piece of steel, pierced with a regular gradation of holes, or a series of progressively diminishing apertures, through which the gold bar, reduced to a rod, is forced and made to assume the form and dimensions of the hole through which it is last drawn. The holes are formed with a steel punch, and are enlarged on the side where the wire enters and diminish with a gradual taper to the other side. A *draw-bench* is sometimes employed in extending the wire, the power being applied by a toothed-wheel, pinion, and rack-work, and is moved by the hands

of one or two persons. For the purpose of the dentist, however, it will be sufficient to fix the draw-plate securely between the jaws of a bench-vise, and, by seizing hold of one end of the gold rod with a strong pair of clamps or flat-nosed pliers, serrated or cut like a file on the inside of the jaws, the wire may be drawn steadily through the plate, passing from the larger to the smaller holes until a wire of the required size is obtained.

In drawing the wire, the motion should be steady and uniform, for if drawn interruptedly or by jerks, the wire will be marked by corresponding inequalities. The gold rod should also be annealed from time to time, and the holes kept well greased or waxed.

REFINING GOLD.

Elements Employed.—The separation of foreign metals from gold by what is termed the "dry method" is effected by the action on them of either oxygen, chlorin, or sulphur, converting them into oxids, chlorids, or sulphids. Certain compound substances are used for this purpose which, when heated and decomposed, yield these elements in sufficient quantities for the purposes specified. The refining agents in common use are *potassium nitrate* (niter, or saltpeter), which yields oxygen; *mercuric chlorid* (corrosive sublimate), which yields chlorin; and *antimony sulphid*, which yields sulphur.

Separation of Foreign Metals from Gold.—The most troublesome ingredients which find their way into gold alloys are what are commonly called *base* metals, as tin, lead, zinc, iron, antimony, bismuth, etc. In attempting to separate these metals from gold, it is not a matter of indifference what reagent is employed, inasmuch as distinct affinities exist, which may be advantageously consulted.

If, for example, zinc or iron or both of these metals are present in small quantities, any compound which yields oxygen will, by virtue of the affinity of the latter for these metals, effect their separation by converting them into oxids; hence, when these metals are to be got rid of, potassium nitrate is employed. But oxygen has a feeble affinity for tin, and when this metal is present, its separation is better effected by some compound which parts with chlorin in the act of decomposition; mercuric chlorid is therefore used for the purpose. When the alloy of gold contains a number of these metals at the same time, and is very coarse, antimony sulphid, which is a very powerful and efficient reagent, should be resorted to, unless the operator should prefer, and which is the better way, to reduce the alloy to pure gold by the "humid method."

The Dry Method.—After all traces of iron or steel have been removed from the gold fragments and filings by passing a magnet repeatedly through them the latter should be placed in a clean crucible, lined on the inside with borax, and covered either with a piece of fire-clay slab or broken crucible. Sheet-iron has been recommended for the latter purpose, *but should never be used, as, when highly heated, scales form on the surface, and are liable to drop in upon the fused metals.* If the operation is likely to be protracted, an inverted crucible, with a hole in the bottom, may be securely luted to the top of the one containing the metals, the refining agents and fluxes being introduced through the opening in the upper crucible. These are then placed in the furnace, on a bed of charcoal, or what is better, a mixture of charcoal and coke, the latter being built up around the crucible, and over it when covered with a second crucible, care being taken that no fragments of fuel are permitted to fall in upon the fused metals. The process is as follows:—

First melt the alloy at a high temperature, to oxidize the base metals; the refining agents may then be added in small quantities from time to time, and the heat continued from half an hour to an hour, according to the coarseness of the alloy. The agents first employed are borax and potassium nitrate (KNO_3). The latter assists the oxidation by parting with its oxygen, when the foreign metals will generally become entirely oxidized and dissolved in the slag.

The crucible should be removed from the fire, and the metals allowed to cool gradually. The crucible may now be broken and the button of gold at the bottom removed and separated from the slag that covers it with a hammer. The gold should then be put into a fresh crucible and remelted for pouring into ingot-molds, which should be previously warmed and oiled. This treatment, with nitrate of potassa and borax, will usually be sufficient, as most metals are oxidizable. If, however, after hammering, annealing, and rolling the ingot, it should still be found brittle, it must be remelted, and some other refining agent employed to remove the traces of the base metals. If it is known what foreign metal is present, the particular reagent which will most readily attack it should be used. But if, as is often the case, the alloy is of uncertain composition, or contains several metals having distinct affinities, the process becomes to some extent experimental, making it necessary to use first one refining agent and then another, until from the appearance and the manipulation of the gold, it is found to be free from alloy. The special reagents employed are as follows:—

When tin or lead is present, add mercuric chlorid, $HgCl_2$ (corrosive sublimate), and zinc chlorid, $ZnCl_2$, or lead chlorid, $PbCl_2$, are formed and with the mercury volatilized by the heat.

When silver is present, add to the molten alloy from two to four times its weight of antimony sulphid, Sb_2S_3; this must be added carefully and a little at a time. The heat decomposes the sulphids. The sulphur unites with the silver and other base metals, forming sulphids, while the antimony unites with the gold, forming a leaden-colored alloy. When effervescence has ceased, remove the crucible from the fire and allow it to cool. The antimony and gold alloy will be found in the bottom of the crucible, and the sulphids on the surface.

Miller's process of separating silver from gold, consists in melting the alloy in a crucible, glazed internally with borax, then by means of a fire-clay tube passing through the lid of the crucible, a current of chlorin gas is forced into the molten mass. The silver and other impurities are converted into chlorids which rise to the surface. After the gold cools the still molten chlorid is poured off. The gold is cleansed from any adhering chlorid, then remelted and cast.

To separate the antimony from the gold, remelt the alloy and throw upon the molten mass a current of air from a blowpipe. Antimony oxid, Sb_2O_3, is formed and volatilized; continue the process until fumes cease to be given off.

When Iridium is Present.—Professor Essig, in writing upon the subject, says: "The little, hard grains occasionally met with in gold, upon which the file makes no impression, consist of iridium, or a native alloy of osmium and iridium and are not combined with the gold, but merely disseminated through it. The only dry method of separating it from gold consists in alloying the latter with three times its weight in silver, by which means the specific gravity of the metal is so much lowered that iridium, which is very infusible and of a specific gravity of 21.1, will subside to the bottom of the crucible, when the gold and silver alloy

may be poured or ladled off. As some of the gold will remain with the residue, more silver must be melted with it, the operation being repeated several times until nearly all the gold is removed." The gold and silver alloy may then be separated as directed above.

When Platinum is Present.—If, after treating the alloy with the reagents enumerated, it should be found malleable, but stiff or elastic and of a rather dull color, it is due to the presence of platinum, and any further attempts to reduce it by the "dry process" will prove unavailing. It must then be subjected to what will hereafter be described as the "humid, or wet method."

The Humid Method.—When it is desired to reduce the alloy to pure gold, which is generally advisable whenever the gold to be refined consists of very coarse filings, fragments of plate containing large quantities of solder, linings with platinum pins attached, particles of base metals, etc., the "humid, or wet method," as it is called, should be employed. The solvents in common use for this purpose are nitric, sulphuric, and nitro-muriatic or hydrochloric acid, but as the desired results can be more conveniently and directly obtained by the use of the latter, or hydrochloric acid, this most available method alone will be given. The following practical remarks on the subject are from an article on the "Management of Gold," by Professor George Watt:—

"When the alloy is composed of metals differing but little in their affinities for oxygen, chlorin, etc., we resort to one of the 'wet methods.' And, in this connection, we will only describe the one which we consider the most convenient and effectual for the practical dentist. It is effectual in all cases, as it always gives us pure gold.

"Let us, then, suppose that our gold alloy has become contaminated with platinum to such an extent that the color

and elasticity of the plate are objectionable. The alloy should be dissolved in nitro-muriatic or hydrochloric acid, called *aqua regia*. The best proportions for aqua regia are three parts of hydrochloric acid to one of nitric. If the acids are at all good, four ounces of the aqua regia will be an abundance for an ounce of the alloy. The advantage of using the acids in the proportion of three to one, instead of two to one, as directed in most of the text-books, is, that when the solution is completed there is but little, if any, excess of nitric acid. If the acids be 'chemically pure,' four parts of the hydrochloric to one of the nitric produces still better results.

"By this process the metals are all converted into chlorids; and, as the chlorid of silver is insoluble, and has a greater specific gravity than the liquid, it is found as a grayish-white powder at the bottom of the vessel. The chlorids of the other metals, being soluble, remain in solution. By washing and pouring off, allowing the chlorid of silver time to settle to the bottom, the solution may be entirely separated from it.

"The object is now to precipitate the gold while the others remain in solution. This precipitation may be effected by any one of several different agents, but we will mention only the protosulphate of iron.

"This salt is the common green copperas of the shops, and, as it is always cheap and readily obtained, we need look no further. It should be dissolved in clean rain-water, and the solution should be filtered, and allowed to settle until perfectly clear. Then it is to be added gradually to the gold solution as long as a precipitate is formed, and even longer, as an excess will the better insure the precipitation of all the gold. The gold thus precipitated is a brown powder, having none of the appearance of gold in its ordinary state. The solution should now be filtered, or the gold

should be allowed to settle to the bottom, where it may be washed after pouring off the solution. It is better to filter than decant in this case, as, frequently, particles of the gold float on the surface, and would be lost in the washings by the latter process.

"Minute traces of iron may adhere to the gold thus precipitated. These can be removed by digesting the gold in dilute sulphuric acid; and, when the process is properly conducted thus far, the result is *pure gold*, which may be melted, under carbonate of potash, in a crucible lined with borax, and reduced to the required carat."

Assay or Testing by the Touchstone.—One of the earliest methods of assaying or testing gold was by the use of the touchstone. The present touchstone is a black jasper, the best specimens coming from India. In testing the fineness of a gold alloy, the metal is rubbed on the touchstone, and the streak thus produced is compared with those made by a series of alloys of known composition, prepared for the purpose and called *touchneedles*. The effect of a drop of nitric acid and dilute aqua regia on these several streaks is also compared. The base metals will be more readily acted upon, and the presence of copper will give a more or less greenish color.

Recovery of Gold from Scrap.—When scrap gold is not free from filings, fragments of solder, and platinum it must be refined or recovered before it can be again worked up into plate. This is accomplished as directed under refining gold.

Recovery from Sweepings.—There is always more or less loss of gold about the laboratory work bench or the operating chair in the office. These fine metal particles become contaminated with dust and other foreign matter, varying considerably in composition.

To recover the gold from the sweepings a magnet is

first passed through the dust to remove any particles of iron which may be present. All organic and other combustible material is gotten rid of by burning it off in an open fire-clay crucible, after which suitable fluxes are added and the remainder is melted. These necessarily vary somewhat, but the following proportion* may be conveniently taken:

Lemel (sweep.)	50 parts.
Sodium carbonate	5 "
Borax	5 "
Potassium bisulphate or nitre	1 to 2 "
Common salt	5 "

The lemel is well mixed with the fluxes, with the exception of the salt, which is kept as a cover for the mixture, as it prevents the mass rising too much and overflowing the crucible. Nitre which oxidizes the base metals and potassium bisulphate should be sparingly employed. The crucible should not be more than half full to commence with, and should be gently heated at first, the temperature being raised gradually. Towards the end of the operation, when the violence of the action has nearly ceased, a more intense heat is employed, and when the whole mass is thoroughly liquid it is well stirred with an iron rod, after which the crucible is removed and contents poured into an ingot mould, care being taken to prevent the "slag" running into the mould. The ingot thus obtained will in many cases be in a suitable condition for rolling. If brittle, the alloy may be "toughened" by remelting with a little charcoal powder.

When it is desired to obtain the gold in a pure state this alloy is treated as directed under refining of gold.

Purple-of-Cassius.—This preparation of gold is so named for its color and its discoverer, M. Cassius. It is employed by manufacturers of artificial teeth in obtaining

* Smith's Dental Metallurgy.

the gum color, and in the manufacture of certain porcelain and glass to give them a red color.

Purple-of-Cassius is a compound of gold, tin, and oxygen, grouped according to the following formula:*

$$Au_2O,\ SnO_2,\ SnO,\ SnO_2 + 4H_2O.$$

It is obtained by mixing a solution of stannous chlorid, $SnCl_2$, stannic chlorid, $SnCl_4$, and a dilute neutral solution of gold chlorid. The result is a fine purple precipitate, which is collected, washed and dried, when it is ready to be incorporated with the sillous material.

Purple-of-Cassius is claimed by many to be merely a mechanical mixture, a combination of stannic oxid, colored with finely divided gold or one of its oxids.

PLATINUM.

Symbol, Pt. *Atomic weight,* 197.

General Properties.—Platinum is a grayish-white metal, resembling, in some measure, polished steel. It is harder than silver, and has a density greater than any known metal, its specific gravity being 21.25. A white heat does not tarnish it, nor is it any way affected by exposure, either in the air or water. It is insoluble in any of the simple acids, *nitro-muriatic acid* (aqua regia) *being the only one that dissolves it.* It expands less by heat than any other metal, and is much inferior to gold, silver, and copper as a conductor of electricity.

Platinum is soft and flexible, and when rolled into thin sheets, say 28 or 30 of the gauge-plate, and well-annealed *at a strong white heat for eight or ten minutes*, it may be readily forced into all the inequalities of a zinc die without producing any appreciable change in the face of the latter.

* Bloxam's Chemistry.

The Fusing Point of platinum is above 3500° Fahrenheit, to reach which, in the laboratory, it is necessary to employ the oxy-hydrogen blow-pipe.

Use for Dental Purposes.—Platinum, in mechanical practice, is chiefly employed as a base for continuous-gum work; as a coloring ingredient of porcelain; for pins for attaching mineral teeth; for backings, and dowels in crown- and bridge-work; and, to a limited extent, in some of the minor operations of the laboratory.

Solder for Platinum.—Pure gold is the only proper solder for this metal.

Alloys of Platinum.—Platinum unites with most of the base metals, forming alloys of variable degrees of hardness, elasticity, brittleness, color, fusibility, etc., but their practical value to the dentist is not sufficient to justify a separate description of their properties.

With gold, it forms a straw-colored alloy, the shade depending on the quantity of gold added. *Silver* hardens it, the resulting alloy being unaffected by sulphur.

Platinoid Metals.—The platinoid metals, palladium, iridium, osmium, rhodium, and ruthenium, are native contaminations, the alloys of these metals having a close general resemblance to platinum.

Among the platinoid metals, palladium and iridium are the only ones that have been used for dental purposes, and these only to a limited extent.

Palladium (Symbol, Pd. Atomic weight, 106), is of a steel-gray color, and when planished, is a brilliant, steel-white metal, not liable to tarnish in the air. Though closely resembling platinum, it may be readily distinguished from the latter metal by the following tests: (1) It has little more than one-half the density of platinum. (2) If a piece of it is heated to redness, it assumes a bronze-blue shade, of greater or less intensity, as it is cooled more or less slowly;

but if it is suddenly chilled by immersing it in cold water, it instantly resumes its original luster. (3) When a drop of the tincture of iodin is let fall upon its surface and evaporated over the flame of a lamp, a black spot remains, which does not occur with platinum. Palladium melts at about the heat required to fuse malleable iron, and is the most fusible of the platinoid metals. It is soluble in nitric acid, but its best solvent is nitro-hydrochloric acid.

Palladium, being very costly, and possessing no properties that specially recommend it for dental use, is but little employed in prosthetic practice.

Iridium (Symbol, Ir. Atomic weight, 193), though generally found associated with platinum, osmium, and other allied metals, sometimes occurs native and nearly pure. It is very refractory when exposed to high temperatures, and can only be fused by the oxy-hydrogen blowpipe or by the heat of the voltaic current.

The extreme hardness and consequent rigidity of iridium renders it in its unalloyed state practically unfit for base plates, on account of the great difficulty of swaging it into proper form.

SILVER.

Symbol, Ag (Argentum). *Atomic weight,* 108.

Occurrence.—Silver is found first, as native silver, that is, in the metallic state, usually in flat masses; sometimes these deposits are of considerable size, weighing several hundred pounds. Silver is frequently found in combination with sulphur and chlorin, and in most of the ores of lead, particularly that of lead sulphid (*galena*). It also occurs in this country mixed with native copper. The most common ores from which silver is extracted are those resulting from its combination with sulphur as sulphids.

General Properties of Silver.—Pure silver, when plan-

ished, is the brightest of the metals. It is very malleable and ductile. It exceeds gold in tenacity or cohesion, but is inferior to platinum in this respect. Fine silver is unaffected by moisture or pure atmospheric air, but is readily tarnished with a film of brown sulphuret by exposure to sulphuretted hydrogen. The sulphuret of silver thus formed may be easily removed by rubbing the metal with a solution of *chameleon mineral,* prepared by calcining equal parts of black or peroxid of manganese and niter. *Unlike gold and platinum, it is readily soluble in nitric acid, this and sulphuric acid being the only simple ones that dissolve it.*

Fusing Point.—Silver fuses at an extreme red heat, generally estimated at 1873° F. It becomes very brilliant when heated; boils and vaporizes above its fusing point; and when cooled slowly its surface presents a crystalline appearance.

Alloys of Silver.—Silver combines readily with most metals, forming compounds of variable degrees of malleability, ductility, density, etc.

Tin, zinc, antimony, lead, bismuth, and arsenic render it brittle. A very minute quantity of tin is fatal to the ductility of silver. Silver does not easily combine with iron, although the two metals may be united by fusion. Gold, copper, platinum, iridium, steel, manganese, and mercury also form alloys with silver.

Refining Alloys of Silver.—The following accounts of the manner of obtaining pure, or nearly pure, silver from alloys of that metal by the dry, and wet, or humid, methods are given by Professor Essig in his treatise on "Dental Metallurgy:"—

Dry Method.—"The dry method, or assaying process, consists in forming an alloy of the silver with lead, and is especially applicable to ores and the sweepings of the den-

tist's laboratory. The specimen to be treated is heated with from twelve to thirty times its weight of granulated lead, in a bone-ash cupel, which is placed in a muffle so arranged that a current of atmospheric air may pass freely over the vessel and oxidize the lead. This oxid of lead, being quite fusible, combines with any base metal present and oxidizes it, uniting subsequently with the oxid as a fusible slag, while the gold or silver will be held by the unoxidized portion of the lead. In the treatment of specimens of alloy, such as plate or coins, a quantity of the specimen is accurately weighed and mixed with from four to five times its weight of pure granulated lead. It is then placed in the cupel and exposed to heat, as above described, until all the lead is oxidized or converted into litharge, when the remaining button assumes the brilliant appearance of surface to which allusion has been previously made, denoting that the base metals or oxidizable constituents have been oxidized and taken up by the lead oxid. This button is then to be weighed by means of a delicate assay balance, and the loss of weight denotes the amount of alloy that was present.

Wet Method.—" Pure silver, which is reckoned as 1000 fine, may be obtained from standard or other grades of silver by dissolving them in nitric acid slightly diluted with water, the solution being much facilitated by exposure to gentle heat. If gold be associated with the alloy it will be found at the bottom of the vessel, in which case it will be necessary to use a siphon to remove the argentic nitrate solution. The silver is now to be precipitated in the form of chlorid by the addition of an excess of common salt. When all has subsided the liquid is carefully poured off, and the chlorid thoroughly washed, to remove all traces of acid. The chlorid is then placed in water acidulated with hydrochloric acid (an ounce of chlorid requiring six to eight

ounces of water) and pieces of clean wrought-iron put in it, when a copious evolution of hydrogen follows, which, uniting with the chlorin of the argentic chlorid, liberates metallic silver. The latter should not be disturbed until the last particle of it is thus reduced, when it will be found to be a spongy mass. The undissolved iron should now be carefully removed, the ferrous and ferric chlorid carefully decanted, and the silver washed in hot water containing about one-tenth its bulk of hydrochloric acid. This is repeated several times, and finally the silver is again thoroughly washed with pure hot water. The silver, after drying, is then ready for melting, and if care has been observed in the process it will be found to be of a fineness of 999.7 parts in 1000, the 0.3 of impurity present being due to traces of iron. The chlorids may be acidulated with sulphuric acid, and reduced with zinc instead of iron."

Reduction of Silver to the Required Forms for Dental Purposes.—Owing to the very soft and flexible nature of silver in its pure state, it is usual, when converting it into plate or other forms for use, to employ an alloy of the metal. Hence silver coins, which are made harder by the copper they contain, are generally selected for the purpose. The tendency of silver to tarnish in the mouth when alloyed with copper may be diminished by boiling the finished piece in a solution of cream of tartar and chlorid of soda, or common salt, or by scrubbing it with aqua ammonia, which removes the superficial particles of copper and exposes a surface of fine silver. When platinum is introduced as the sole alloying component, the purity of the silver is not only preserved, but the alloy is less easily acted on chemically.

Formulas for Silver Solders.—Silver solders are usually composed of silver, copper, and zinc in variable proportions. Alloys formed from the following formulas are such as are generally employed in soldering silver plate derived from

the coins of that metal. Three-cent pieces, composed of two parts silver and one of copper, may be used for the same purpose:—

Formula No. 1.		*Formula No. 2.*	
Silver,	66 parts.	Silver,	6 parts.
Copper,	30 "	Copper,	2 "
Zinc,	10 "	Brass,	1 part.

In compounding silver solders, the silver and copper should be first melted, and the zinc or brass afterward added, when they should be quickly poured, to prevent undue waste by oxidation of the more fusible component. The ingot, when cold, should be rolled into a plate a little thicker than that recommended for gold solder.

ALUMINUM.

Symbol, Al. *Atomic weight,* 27.

Occurrence.—Aluminum is the metallic basis of alumina, the latter being the characteristic ingredient of common clay. It is only within a comparatively few years that the attention of chemists has been directed to the production of this metal, with a view to its general introduction into commerce and the arts. The improvements in the methods of obtaining it, which have been more recently introduced, have rendered its production economical; and it is now supplied in large quantities and in a greatly improved condition.

General Properties.—Commercial aluminum is never chemically pure, and therefore displays properties varying more or less from the absolutely pure metal. The impurities usually present are iron and silicon, which vary from 1 per cent. to 6 per cent.* One of the most striking

*Grade No. 1, produced by the Pittsburgh Reduction Co., has of Aluminum 99.55 per cent., Iron 0.15 per cent., and Silicon 0.30 per cent. This company however, for special purposes, produces a metal running as high as 99.90 per cent. pure.

properties of aluminum is its extreme lightness, it being the lightest of commercial metals, having a specific gravity of 2.6, whilst that of platinum is 21.5 and gold 19.5. It is very malleable and ductile, and can be reduced to thin sheets or drawn into very fine threads. Its tenacity, though superior to that of silver, is less than that of copper, but no very accurate experiments have been made in this respect.

When pure it is about as hard as silver, is readily manipulated, and is capable of taking and retaining a very high polish.

Fusing Point.—Aluminum melts at a temperature between silver and zinc, or about 1160° F. (according to the latest experiments). When casting aluminum it should not be heated much above the fusing point, or be allowed to remain melted for any great length of time.

Corrodibility.—One of the most marked qualities of aluminum is its resistance to oxidation, from the influence of the air. As now manufactured, this metal is also found to withstand the action of organic secretions fully as well as silver, and is receiving a much larger use as a base for dental plates.

Solubility.—The natural solvent for aluminum is hydrochloric acid. Concentrated sulphuric acid also dissolves aluminum, while nitric acid, either concentrated or diluted, has very little action upon it. Aluminum is also soluble in solutions of caustic potash or soda.

Electrical Conductivity.—Pure aluminum has an electrical conductivity of about one-half that possessed by silver or copper, and about two-thirds that of gold.

Manner of Annealing.—For the purpose of annealing aluminum the surface of the plate may be coated with oil, and then passed over the flame of a spirit lamp or Bunsen burner until the oil is entirely burned off and the plate becomes white, when it is instantly withdrawn. Or it may

be accomplished by placing the piece of plate in a furnace muffle, an even heat being maintained until the metal is hot enough to char the end of a pine stick, which should leave a black mark behind it as it is drawn over the plate. The metal on being withdrawn should be allowed to cool slowly.

Melting.—Aluminum should be melted in ordinary plumbago crucibles. The metal does not absorb or unite with carbon when heating in contact with it. No flux is needed to cover the molten metal, as it is non-volatile at any temperature that can be obtained with an ordinary furnace.

Casting.—Aluminum is now being used to considerable extent in castings of all descriptions where lightness, non-corrodibility, and silvery color are desired. Either iron, sand, or plaster and marble dust molds can be used, the metal being poured as cold as possible.

Polishing.—The truly distinctive and beautiful color of aluminum is best brought out in highly polished plate. To polish, use rouge or tripoli; or "Almeta Polish," which was introduced by the Pittsburgh Reduction Co., and has earned a well-merited reputation as an aluminum polish. Its formula is as follows:—

Stearic Acid, ... one part,
Fuller's Earth, ... one part,
Rotten Stone, ... six parts.
The whole ground very fine and well mixed.

Soldering.—Several methods of soldering aluminum have proven more or less successful for some purposes; none of them, however, are suitable for attaching artificial teeth to be worn in the mouth. The only way in which the metal has been successfully employed as a dental base is with the rubber attachment.

Alloys.—Aluminum, like iron, does not unite with mer-

cury, and scarcely at all with lead. It, however, forms a variety of alloys with other metals. It seems to unite readily with zinc, and these have been found to give the best promise as solders for aluminum; but, unfortunately, when melted, neither of them are sufficiently liquid and do not run readily. A variety of alloys with nickel have been made, and that consisting of 100 parts of aluminum and 3 of nickel is found to work readily, and to have gained hardness and rigidity as compared with the pure metal. The alloys, however, with copper are the most striking; they are light and very hard, and capable of a fine polish. In the same degree that copper adds to the hardness of aluminum, so does the latter, when used in small quantities, give hardness to copper without injuring its malleability.

ZINC.

Symbol, Zn (Zincum). *Atomic weight,* 65.

Occurrence.—The chief forms of zinc as found in nature are the red oxid; the sulphid, *zinc-blend;* and the hydrous silicate, *Calamine.* These ores are roasted to expel carbonic acid, water, and sulphur, after which they are mixed with small particles of powdered coke or charcoal and distilled at full red heat in earthen retort. Carbon monoxid escapes, while the metallic zinc liberated distills over into proper receivers.

General Properties.—Zinc is a bluish-white metal, the fresh surface possessing considerable luster. It does not easily tarnish in dry air, but soon becomes dull on exposure to moisture. Under ordinary circumstances it is brittle, but when heated to about 300° F. it becomes malleable and ductile.

The fusing point of zinc is about 775° F., and when heated to about 1800° F. it boils, volatilizes, and burns, if

the air is not excluded, with a brilliant, greenish-white flame, the oxid being formed.

Use for Dental Purposes.—Zinc has been long employed in the formation of dies used in swaging metallic plates, this being its principal use in the dental laboratory.

Several of the compounds of zinc are employed in operative dentistry in the preparation of plastic fillings. Zinc oxid, ZnO, is the only known compound of zinc and oxygen, and is the basis of most of the plastic fillings, known as oxy-phosphate, oxy-chlorid, and oxy-sulphate of zinc.

LEAD.

Symbol, Pb (Plumbum). *Atomic weight,* 206.5.

Occurrence.—The chief source of lead is from the ore known as *galena,* PbS, or lead sulphid. This ore is broken up and roasted at a dull red heat when it becomes oxidized and converted into sulphate. At this stage of the operation the contents of the furnace are thoroughly mixed and the temperature raised, which causes the sulphid and the sulphate to act upon each other, producing sulphurous oxid, and metallic lead.*

General Properties.—Lead has a grayish-blue color, with a bright, metallic luster when melted or newly cut, but it soon becomes tarnished when exposed to the air. It is both malleable and ductile, but soft and perfectly inelastic.

The fusing point of lead is 617° F. Exposed to a high heat, it absorbs oxygen rapidly, forming on its surface a gray film of protoxid and metallic lead.

Fusible Alloys.—The alloy known as Rose's Fusible Metal is composed of two parts of bismuth to one of lead and one of tin, and melts at about 200° F. A still more

* Essig's Metallurgy.

fusible alloy is composed of lead 3 parts, tin 2 parts, and bismuth 5 parts, which fuses at 197° F.

Soft solder is an alloy composed of lead and tin in the proportion of two parts of the former to one of the latter.

Use in the Laboratory.—Lead, either in its pure state or when alloyed with certain other metals, serves important purposes in the dental laboratory. In its simple or uncombined state it is useful only in forming counter-dies, in swaging plates, and for striking up cusps in crown- and bridge-work. Alloyed with antimony, with the addition, sometimes, of very small portions of copper, tin, and bismuth, it forms different grades of type-metal, which is harder than lead and very brittle, and is sometimes used for dies.

TIN.

Symbol, Sn (Stannum). *Atomic weight,* 117.5.

Occurrence.—Tin is found in nature chiefly as dioxid, SnO_2. This is practically the only ore of tin, and it occurs in large quantities in comparatively few localities. This ore is known as *tin-stone* or *cassiterite*, and is usually mixed with other minerals.

The finely crushed ore is roasted to expel any sulphur or arsenic which may be present. The tin oxid is then mixed with powdered coal and smelted; carbon from the anthracite combines with the oxygen, forming carbon monoxid, liberating the tin.

General Properties.—Tin is a brilliant, silver-white metal, the luster of which is not sensibly affected by exposure to the air, but is easily oxidized by heat. It has a slightly disagreeable taste, and emits, when rubbed, a peculiar odor. It is soft, inelastic, and when bent emits a peculiar cracking sound called "the creaking of tin." It is inferior in tenacity and ductility, but is very malleable.

The fusing point of tin is about 440° F.; it boils at a white heat, and burns with a blue flame to binoxid.

Dental Uses.—In its pure state, it is sometimes used for counter-dies, and occasionally for dies. When employed for the latter purpose in connection with a lead counter, the latter should not be obtained directly from the die, as the high temperature of melted lead would produce, when poured upon the tin, partial fusion of the latter, and consequent adhesion of the two pieces. Tin is also used by many operators as a trial base plate for artificial dentures instead of wax, gutta-percha, or other more pliable materials.

COPPER.

Symbol, Cu (Cuprum). *Atomic weight,* 63.2.

Occurrence.—Copper ores are found in many parts of the world. The metal is found native in some localities in large quantities, notably in the Lake Superior region, where the richest copper mine in the world (Calumet and Hecla) is located.

The ore most commonly employed for the production of this metal is copper pyrites, $CuFeS_2$, a combination of sulphid of copper and iron. This ore contains about 34.5 per cent. copper. It is heated in a reverberatory furnace to obtain a compound of sulphur and copper. The iron sulphid is converted into oxid. The roasted mass is then smelted, when a portion of the copper is oxidized to copper oxid, which as the temperature increases, reacts upon the remaining copper sulphid, resulting in sulphur dioxid, which escapes, and metallic copper. The copper secured is further purified by a refining process.

General Properties.—Copper is of a brownish-red color, with a tinge of yellow; has a faint but nauseous and disagreeable taste, and imparts when exposed to friction a

smell somewhat similar to its taste. It is both malleable and ductile, but excels in the former property, finer leaves being obtained from it than wire. It is inferior to iron in tenacity, but surpasses gold, silver, and platinum in this respect.

The Fusing Point.—Copper fuses at about 2000° F.

Alloys of Copper.—Copper unites readily with most metals, forming alloys of great practical value in the arts, but which have but a limited application in dental laboratory processes. Many of these alloys are curious and instructive, as illustrating the singular and unaccountable influence of alloying upon the distinctive properties of the component metals. The following summary embraces the names and composition of the more familiar alloys of copper, omitting, as unnecessary in this connection, a description of their individual properties.

Alloys of Copper with Zinc.—Brass is an alloy of uncertain and variable composition, consisting usually, however, of two to five parts of copper and one of zinc. Prince's Metal, and its allied compounds, Pinchbeck, Similor, and Manheim gold, consists of 100 parts of copper and from 52 to 55 of zinc. Dutch gold, from which foil of that name was formerly obtained, is formed of 11 parts of copper with 2 of zinc.

Brass solder consists of about two parts of brass and one of zinc to which a little tin is occasionally added.

Alloys of Copper with Tin.—Bell metal usually consists of 100 parts of copper with from 60 to 63 parts of tin. Cannon metal is compounded of 90 parts of copper with 10 of tin.

German silver is composed of copper, 40.4; nickel, 31.6; zinc, 25.4; iron, 2.6; but the proportion of the metals of this alloy differ according to the various uses to which this compound is applied.

Babbitt metal is a compound of copper, antimony, and tin in about the following proportions:—

Copper,	2 parts.
Antimony,	3 parts.
Tin,	12 parts.

The antimony must be added after the other metals are perfectly fused and mixed.

This alloy is used in the dental laboratory for dies, and is thought by many to be superior to zinc for that purpose.

IRON.

Symbol, Fe (Ferrum). *Atomic weight,* 56.

Occurrence.—Iron in the form of compounds is one of the most abundant and widely distributed elements in nature. It is present in nearly all forms of rock and earth, and imparts various shades of color, it being the most widely diffused natural mineral coloring material. Iron is also found in varying proportions in most of the vegetables, and is a very important component of animal tissue. It enters into the composition of the human blood in about one part per thousand.

It is found in small quantities as *meteoric-iron* of terrestrial origin; in combination with oxygen forming the minerals *magnetite* and *hematite,* with oxygen and water the brown hematites, and with carbonic acid the *spathic ore.*

Properties.—Pure iron in compact masses has a grayish-white color, is tolerably soft, and tough. It does not oxidize when exposed to dry air, but in moist air it rusts rapidly, and is converted into ferric oxid.

At ordinary temperatures it is one of the most rigid or unyielding of metals, but by heating it is rendered so ductile that it may be rolled into thin sheets or drawn into the finest wire. It is during this plastic stage, through which it

always passes before it fuses, that two pieces may be brought together and made to cohere by pressure or hammering, the process known as welding.

It is not upon the physical properties alone that the value of iron depends, as it enters into many compounds which are of much use to the arts, and its chemical relation to carbon is such that the addition of a small quantity of the latter will convert it into steel, which is harder and more elastic than iron, while the addition of a larger quantity of carbon produces cast-iron, which is more fusible and brittle. Thus we have three distinct grades or modifications of iron,—*cast-iron, wrought-iron, and steel.*

Cast-iron.—This is the product obtained by smelting ores of iron in the blast furnace, and is commonly known as *pig iron.* It usually contains 2 to 4 per cent. of carbon, 0.2 to 3 per cent. of silicon and about 1 per cent. of manganese, with small amounts of sulphur and phosphorus.

It differs from wrought iron or steel in being non-ductile, more brittle, therefore not so tough, and is harder than malleable iron.

Wrought-iron.—Wrought-iron, or malleable iron, is probably the nearest approach to pure iron which can be produced in a commercial way. This form of iron contains from 0.05 to 0.3 per cent. of carbon, and is comparatively soft, very malleable, ductile and tenacious. By this we understand that as far as practicable the foreign substances have been removed from the pig iron by a process of refining, known as puddling or Bessemerising.

Wrought-iron may be magnetised by keeping it in contact with a magnet; it loses the property however as soon as the magnet is removed. Heating to redness and plunging into cold water does not harden it, as steel is hardened when similarly treated.

Steel.—The marked apparent difference in steel and

wrought-iron is, as has just been indicated, that steel has the property of becoming very hard when heated to redness and suddenly plunged into cold water. This property is given the iron by the presence of a definite quantity of carbon, varying from 0.75 to 2 per cent. The working quality of steel is modified by the presence of other foreign substances. A small quantity of sulphur will render it *red-short* or practically unworkable at red-heat, while a small amount of phosphorus will make it *cold-short*. When too much sulphur is present, the addition of a small quantity of manganese will counteract to some extent its harmful influence. Silicon imparts hardness and brittleness.

Fusing Point.—The fusing point of pure iron is estimated to be about 2900° F., while the amount of carbon introduced in forming the different modifications of iron relatively reduces the point of fusion.

Hardening and Tempering Steel.—The hardening of steel is effected by subjecting it *suddenly* to extremes of temperature. Conversely, the hardened steel, reheated to redness and allowed to cool *slowly*, is again converted into soft steel. Any desired variation between these points may be obtained by taking the *hardened* steel, carefully reheating it to the proper point (see table), and stopping the operation at that moment by suddenly chilling it; this constitutes *tempering*.

In writing upon this subject in the "American System of Dentistry," Dr. Kirk directs that where small articles, such as drills, excavators, and other dental instruments, are to be hardened, they should always receive a protective coating of some material which will retard or prevent loss of carbon by oxidation during the heating process. Common soap answers admirably for this purpose. After being heated carefully to the proper temperature, which has been previously determined by experiment, the instrument is suddenly

chilled by plunging it into water or some medium which will rapidly abstract its heat. Water alone, or with the addition of small proportions of acid or salt—the first to aid in the separation of the scale or oxid, the latter to increase conductivity—is most commonly used, though in some instances where extreme hardness is desired mercury is used, which, on account of its superior conductivity, chills the heated metal instantly. With water the chilling process is slower, it being an inferior conductor, and when articles of considerable size in a heated state are plunged into it actual contact of the cold water is prevented for a moment by the formation of an envelope of steam, which surrounds the hot metal and protects it. This does not occur when the mercury bath is used.

The approximate temperatures corresponding to the various tints are shown in the following table:—

Temperature.	Color.	Temper
430° to 450° F.	Very faint yellow to pale straw.	Lancets, razors, surgical instruments, enamel chisels.
470°	Full yellow.	Excavators, very small cold-chisels.
490°	Brown.	Pluggers, scissors, pen-knives.
510°	Brown with purple spots.	Axes, plane-irons, saws, cold-chisels, etc.
530°	Purple.	Table-knives, large shears.
550°	Bright blue.	Swords, watch springs.
560°	Full blue.	Fine saws, augers.
600°	Dark blue.	Hand and pit saws.

ANTIMONY.

Symbol, Sb (Stibium). *Atomic weight*, 120.

Occurrence.—Antimony is found in the metallic state in nature in various parts of the world. It is chiefly found, however, as gray antimony ore, or *stibnite*, which is a sulphid, Sb_2S_3, occurring most abundantly in Cornwall and Hungary.

This ore is broken up and heated with scrap iron, the sulphur unites with the iron, forming iron sulphid, the antimony being liberated.

General Properties.—Antimony is of a silver-white color with a tinge of blue. It is brittle and easily pulverized. It enters as an ingredient into the composition of type and stereotype metal, music plates, and Britannia metal. It is also a component of certain fusible alloys analogous to those already mentioned under the head of lead, and which, in the form of a die, are sometimes used on account of their slight degree of shrinkage.

The Fusing Point of antimony is 840° F., and when heated at the blowpipe it melts with great readiness, and diffuses white vapors, emitting an odor similar to garlic.

BISMUTH.

Symbol, Bi (Bismuthum). *Atomic weight,* 207.5.

Occurrence.—Bismuth is found chiefly in nature, in the metallic state, and combined with oxygen, sulphur, and associated with the ores of cobalt, tin-stone, and sometimes gold and silver. Owing to its low fusing point it is heated in suitable furnaces and readily separated from accompanying substances and runs off.

General Properties.—Bismuth is a white-colored metal, resembling, in some degree, antimony. It is soft, but so brittle as to be easily pulverized. Bismuth is the poorest conductor of heat and electricity amongst the common metals.

The Fusing Point.—Bismuth fused at about 510° F.

Alloyed with Other Metals.—Bismuth has the property, in a high degree, of increasing the fusibility of the metals with which it is incorporated, and is a common ingredient of the more fusible alloys, some of which melt in boiling

water. One part of bismuth with 24 of tin is malleable, but the alloy of these metals becomes brittle by the addition of more bismuth. Bismuth unites readily with antimony, and, in the proportion of one part or more of the former to two of the latter, it expands in the act of cooling.

Dental Uses.—The principal use of bismuth in the dental laboratory is as a constituent of certain alloys, known as *fusible metals.*

MERCURY.

Symbol, Hg (Hydrargyrum). *Atomic weight,* 200.

Occurrence.—Mercury is frequently found in nature in the metallic state. It is sometimes found disseminated through the vein-stone in mines of this metal, and trickling from crevices in the ores. It is also found in globules disseminated through its most important ore, its sulphid, or *cinnabar,* HgS, which is the principal source of its supply.

The principal mines are in Spain, Austria, China, Australia, and California. It has been found in great abundance and of remarkable purity in the California and Australian mines.

Extraction.—Two general methods for extracting mercury from its ore are in use. *The first* is to simply roast the cinnabar, with access of air, which converts the sulphur into sulphurous anhydrid and pure mercury, liberated in the form of vapor, which is condensed in suitable receivers. *The second* is to mix the sulphid with lime or oxid of iron and distil the mixture. The sulphur combines with flux to form calcium or iron sulphid as the case may be. The mercurial vapors are condensed as before, in receivers.

General Properties.—Mercury, in the solidified condition, is malleable and ductile. It is silvery-white in color, and has a strong metallic luster. It is readily distinguished from other metals by its liquidity, which it maintains at

all ordinary temperatures. It is soluble in dilute nitric acid and hot sulphuric; insoluble in hydrochloric acid.

Mercury unites more or less readily with all the metals excepting iron and platinum; the latter metal will unite, however, in the spongy condition. After this union of mercury with another metal has taken place it is known as an amalgam.

Fusing Point.—Mercury fuses at 40° below zero. F. Above this temperature it is fluid; it boils at 660° F.

Compounds.—*With Oxygen* mercury unites to form two classes of compounds, mercuric and mercurous oxids, both of which are highly poisonous. *With Chlorin* it forms two compounds, mercuric chlorid (corrosive sublimate) and mercurous chlorid, familiarly known as calomel. *With Iodin* it forms two compounds, mercuric iodid and mercurous iodid. *With Sulphur*, it combines to form sulphates and sulphids.

Vermilion, or mercuric sulphid, HgS, is a compound of mercury extensively used in coloring vulcanisable rubbers and celluloid. This is manufactured by heating in suitable receptacles, mercury four parts with fine flowers of sulphur one part.

Detection of Impurities.—Commercial mercury is never quite pure, being more or less contaminated with lead, tin, zinc, etc. A trace of these is contained in the metal as it is made, but unscrupulous dealers frequently add base metals to increase their profits, as a considerable amount of such adulteration can take place without interfering with its fluidity.

To detect the presence of foreign metals, allow a large globule of the suspected sample to roll over the surface of a sheet of white paper, when, if the metal is impure, it will leave a streak of dross in its track, which will not occur when it is absolutely pure.

Only chemically pure mercury should be employed in the preparation of dental amalgams. This can now be obtained from reliable dealers.

Method of Refining.—The method most frequently employed for the purification of mercury is distillation. The mercury is placed in a retort and is covered with about one-fifth its weight of powdered *cinnabar*. The cinnabar suffers decomposition during distillation of the mercury, and the mercury it contains is also distilled over, while the impure metals are largely converted at the same time into sulphids, remaining with the other impurities in the retort. To further purify the mercury, it is taken from the receiver and bathed for several hours in dilute nitric acid with gentle heat. The acid dissolves out impurities and any traces of more readily oxidisable metals.

AMALGAMS.

Amalgam is the name given to an alloy of mercury and one or more other metals.

Dental Amalgams.—The constituents of amalgams employed in dentistry are usually silver, tin, gold, and platinum in varying proportions, with mercury. Zinc, copper, and other base metals are sometimes employed, according to many different formulæ.

Properties Desirable in Dental Amalgams.—An alloy for dental amalgam should possess the qualities of (1) strength to withstand the force of mastication; (2) strength and sharpness of edge; (3) being capable of retaining its shape and (4) as far as possible, free from discoloration. It is also evident that an amalgam liable to expand to any great extent or contract is not to be relied upon as a filling material.

Discoloration of Amalgam Fillings.—The discoloration of

amalgam fillings in the mouth is largely due to the formation of sulphids. According to Essig,* the fluids of the mouth, in every case where the most scrupulous cleanliness is not observed, may be said to contain sulphur in combination with hydrogen, as dihydric sulphid (H_2S), resulting from decomposition of particles of food having a lodgment between or adhering to the teeth. The affinity of sulphur for both silver and mercury is so active that we may reasonably assume that not only the discoloration of amalgam fillings, but in many cases their failure to prevent a recurrence of decay, is due to the action of that element upon the alloy.

Formation of Amalgam Alloys.—An alloy consisting of silver, tin, gold, and platinum being a typical combination, the method of producing the same will illustrate the process sufficiently, there being little modification where other metals are used.

The plumbago, or graphite, crucible is preferable; it should be brought to a bright-red heat and a sufficient quantity of borax dropped in and allowed to fuse to coat the whole inner surface, after which the silver and gold, with the platinum in small pieces, should be introduced and thoroughly fused. The tin is then added and the fluid mass poured into suitable molds. After it is thoroughly cooled it may be brought into a suitable state for use, either with a clean file or with a chisel in a lathe.

EFFECT OF CONSTITUENT METALS ON AMALGAMS.

Silver.—The greater number of amalgams consists largely of silver and tin, silver being the first and most important metal for a good amalgam alloy. The union of silver with

* Essig's "Metallurgy."

mercury is accompanied with expansion while the union of tin and mercury causes contraction. The influence of silver therefore upon an amalgam of tin and mercury is to lessen shrinkage, and increases the hardness. Silver, however, discolors very readily, owing to its affinity for sulphur. A coating of silver sulphid forms upon the surface through the action of sulphureted hydrogen in the mouth.

Tin as indicated causes contraction or shrinkage; it facilitates amalgamation and helps to prevent discoloration. Tin retards setting and decreases edge strength.

Gold in amalgam, that is in small quantities, makes it work easier, that is makes the mass smoother and more plastic; reduces shrinkage, increases edge strength and, it is thought, assists in maintaining good color. If more than 7 per cent. of gold is used it makes the amalgam brittle.

Platinum, when added to a silver and tin amalgam in any considerable amount, impair the properties of the alloy. It causes dirtiness in working, retards setting, and increases shrinkage. In small quantities it is said to impart strength and density, and to resist discoloration.

Zinc in small amounts is occasionally employed in making dental amalgam alloys. This is done to add whiteness to the amalgam, and help it retain its color. So-called white amalgams contain a large amount of zinc. Its presence, however, causes rapid setting and a tendency to contract.

Copper diminishes shrinkage, hastens setting, is compatible with tooth structure and favors tolerance of metallic fillings near the pulp. The great objection to copper is its tendency to marked discoloration.

Cadmium for a time was used in amalgam alloys, but has been discarded as the tooth substance became stained, owing to the formation of soluble salts of cadmium.

Antimony has also been experimented with. It was found to lessen the strength of the amalgam and make it dirty to work.

Bismuth facilitates the working properties of amalgam, but increases the discoloration in the filling, and lessens the edge strength, hence is not employed.

Palladium was found to make the amalgam very dirty to work, and caused leaky and black fillings.

Aluminum gives a soft easy working mass, but very slow to set, causes increased expansion and has a tendency to further alter its shape.

Change of Volume.—The change of form in amalgam fillings has long been recognized as one of the chief disadvantages of this class of operation. Much tedious and careful work has been done by dentists, metallurgists and manufacturers to overcome this feature, and the more recent researches of Dr. Black have gone far towards remedying it.

In testing amalgams for change of form, the usual method is to firmly pack freshly mixed amalgam into a shallow glass tube, leaving the top perfectly smooth and level with the edges of the tube. If the amalgam contracts it will readily slide out of the tube, while if there is any expansion it may be determined by the slight projection of the metal above the mouth of the tube.

It has been shown that alloys containing less than 50 per cent. of silver first shrink and then expand, while 50 to 60 per cent. causes shrinkage only. Above 65 per cent. of silver gives more or less expansion. In Dr. Black's experimental investigations, the contraction and expansion of silver-tin amalgams has been very carefully studied, both with the microscope and a measuring instrument known as a micrometer.

For the purpose of examining amalgams under the microscope, the plastic metal is packed into a "Wedelstaedt test-tube, made of hardened steel one-half inch deep and one inch in diameter, with a cavity three-eighths of an inch in diameter and one-fourth of an inch deep. The top of the

tube is ground flat and the margin of the cavity brought to a perfect edge. The tubes are placed on the stage of the microscope and so arranged that every part of the margin of the cavity is brought under the lense as the stage is rotated. A groove is cut in the inner wall of the tube at the bottom, to hold the filling at that point, so that in case of shrinkage the surface of the filling sinks down into the tube."*

Edge-strength.—As the term indicates, it denotes the resistance the edge of an amalgam filling offers to the force of mastication. One of the requirements of a dental amalgam is that it should have more than sufficient edge strength to retain its edge integrity under all ordinary circumstances. " The stress in the ordinary uses of the teeth has been shown to be from sixty to eighty pounds upon the area of the molars of medium size. This, if evenly distributed, would give from seven and a half to ten pounds on a filling occupying one-fourth the area of one of these teeth."†

Annealing and Aging of Amalgam Alloys.—With the lapse of time, after an amalgam alloy has been cut, the particles of metal become more or less oxidized. This oxidation has an influence upon the working properties of the alloy, in some cases it is facilitated while with others it seems to retard it. This change is technically called " aging," and it is generally believed to have a beneficial effect. Dr. Black's experiments demonstrate that oxidation or " aging " retards setting, though in varying degrees with different formulæ; also that this change could be brought about artificially. The explanation of the changes which occur in a silver-tin alloy by annealing is that the alloy becomes hardened in cutting, and that the heating or annealing causes the molecules to return to their normal relative positions.

* Smith's Metallurgy.

† Dr. Black in Dental Cosmos.

Quantity of Mercury Required.—The percentage of mercury used for the amalgamation of different alloys varies with the constituents of the alloy. Sufficient mercury must be used to satisfy the chemical affinity of the other metals, but if too much be used it results in a solution of the alloy. An "aged" alloy requires less mercury than the same metal freshly cut. From 40 to 60 per cent. of mercury is usually employed.

Composition of Standard Alloys.—The following table, taken from Dr. Kirk's article in the "American System of Dentistry" shows the composition of some of the principal dental amalgam alloys in use:—

	Tin.	Silver.	Gold.	Platinum.	Copper.	Zinc.	Cadmium.
Caulk's Par-excellence	61.75	27.25	0.15	0.25	10.60	.....	.....
Dawson's Superior Amalgam	63.55	31.85	0.65	0.15	2.35	1.45	.....
Essig's Alloy	55.	45.	2.5	2.5	.....	.....	.....
Fletcher's P. and G. Alloy	50.35	43.35	3.35	1.30	1.65	.....	.....
Flagg's Contour Alloy	37.	58.	5.	.....	.....	.....	.....
Globe (S. S. White's)	53.36	44.74	1.50	0.40	.....	.....	.....
Hood & Reynold's G. and P. Alloy	50.40	44.30	3.80	.30	.....	1.20	.....
Johnson & Lund's Extra Amalgam	61.15	36.75	.15	.50	.....	.....	1.45
Justi's Superior G. and P. Alloy	59.10	35.20	0.32	0.08	3.50	1.80	.....
King's Occidental	54.75	42.75	.....	.....	.....	2.50	.....
Lawrence's Amalgam	50.43	44.06	.....	.....	5.51	.....	.....
Pierce's Dental Alloy	40.	55.	4.	.....	.....	1.	.....
Sibley's G. & P. Alloy	54.65	43.15	0.20	2.00	.....	.....	.....
Townsend's Improved	54.50	44.50	1.	.....	.....	.....	.....
Welche's G. and P. Alloy	51.90	46.00	1.70	.40	.....	.....	.....

ALLOYS, THEIR TREATMENT AND BEHAVIOR IN THE PROCESS OF COMPOUNDING.

General Properties.—By forming certain definite alloys the number of useful metals has been very largely increased, and the most useful alloys, in a commercial way, are usually those whose constituents are most dissimilar. All alloys possess metallic luster, are opaque, conduct heat and elec-

tricity, and, in a greater or less degree, are ductile, malleable, elastic, and sonorous. Some alloys, as brass and gong metal, are usually malleable in the cold and brittle when hot.

Metals sometimes unite in atomic ratios, forming compounds of definite or equivalent proportions of the component metals, as certain alloys of copper and zinc, gold and copper, gold and silver, mercurial alloys, etc., while, on the other hand, many are formed in all proportions, like mixtures of salt and water.

Metals differ in respect to their affinity for each other, and do not, therefore, alloy with equal facility; thus it is difficult to unite silver and iron, but the former combines readily with gold, copper, or lead.

The ductility of an alloy is, in general, less than that of its constituent metals, and this difference is, in some instances, remarkably prominent, as in the case of certain alloys of copper and tin, already mentioned.

An alloy is generally harder than the mean hardness of its components, a property which, when taken in connection with their increased fusibility, gives to alloys peculiar value in the formation of dies for stamping purposes. To the rule stated, amalgams, or mercurial alloys, are cited as exceptions.

The density of an alloy varies with the peculiar metals composing it, being generally either greater or less than the mean density of its several conponents.

Usual Methods of Producing Alloys.—Alloys are usually formed by fusion, that is, by causing metals to unite by fusing or melting them together. One metal is melted, and then one or more metals, as the case may be, is added to it; sometimes in the fluid state, but more frequently in a solid. It does not follow, however, that the metals will remain in a proper state of mixture by simply fusing them together. The difference in their specific gravity must frequently be

reckoned with. If, for example, lead and zinc were melted together and allowed to slowly cool the two metals would be almost completely separated. The lead, being the heavier, would be found at the bottom of the receptacle. Such mixtures should therefore be thoroughly stirred and poured at the lowest temperature possible.

Eutectic Alloys.—With certain alloys there is, on solidification, a tendency for one of the constituents to become concentrated at one point, thus giving a casting, if one were being made, not perfectly homogeneous. "It is now well established that most of the possible associations of any two metals have more than one point of solidification, and do not 'freeze' as pure water does at a single point." There is, however, in many series of alloys one particular association of the metals which is more fusible than the rest of the alloys of the series. This alloy is called the *eutectic* alloy, and it possesses a *single point* of solidification; that is, when the eutectic alloy is cooled it sets sharply as a whole at a given temperature. Many associations of two metals contain an eutectic alloy and consequently have two points of solidification.

As a molten mass of alloy cools down it begins to soldify at a certain point, but the *eutectic alloy*, on account of its low solidifying point, remains fluid, and entangled in the portion which has set, until the temperature falls to the solidifying point of the eutectic alloy, at which temperature solidification of the mass is completed. There is, therefore, in many cases abundant opportunity in the interval between the initial point of solidification of the alloy and that of the eutectic for the mass to arrange itself in a peculiar way which frequently results in a want of uniformity of the mass.

The exact composition of the eutectic alloy is difficult to determine. The most recent experiments have shown that the composition does not in general correspond with simple atomic proportions of the component metals, and this fact,

and the theory of the subject, point to the conclusion that the eutectic alloy is not generally a compound, and hence should not have a formula. Further research, however, is necessary before any definite conclusion on this point can be generally accepted. The tendency of the constituents to separate on cooling is known as *liquidation,* and is a matter of importance in casting alloys for industrial purposes. In some instances where liquidation has taken place a more homogeneous alloy may be obtained by breaking up the ingot and remelting.*

The Fusing Point.—It is impossible to predict with certainty the melting point of an alloy from that of its separate constituents, but, generally, the fusibility of the alloy is increased, sometimes in a most remarkable degree. The alloy of 5 parts of bismuth, 3 of lead, and 2 of tin is a striking example of this fact, this compound melting at 197°, while the mean melting point of its constituent is 514°. Silver solder is also a familiar illustration of the influence of alloying on the fusibility of metals; copper, melting at 1996°, and silver at 1873°, when combined fuse at a heat much below that required to melt silver, the more fusible component of the alloy. Examples might be multiplied, but it will be sufficient to add that, in general, *metallic alloys melt at a lower heat than is required to fuse the most refractory or infusible component, and sometimes than the most fusible ingredient.*

The color of an alloy cannot, in general, be inferred from that of component metals; thus it would be conjectured that copper would be rendered very much paler by adding to it zinc in considerable quantities, but the fallacy of such an inference is at once shown by an examination of some of the richlooking gold-colored varieties of brass, as Prince's metal, pinchbeck, and similor, composed each of nearly equal

* Smith's Metallurgy.

parts of copper and zinc; and Manheim gold, compounded of 3 parts copper and 1 of zinc.

The several properties peculiar to alloys enhances the value of many metals for industrial purposes. Copper, taken as an instance, has a fusing point too high for ordinary casting, and is too tough for turning, but with the addition of a little zinc it becomes harder and more elastic; the fusing point is lowered so much that castings may be made, and it may be readily turned in a lathe.

Composition of the more familiar alloys, though variable, is about as follows:

Gold Coin.		Gold Plate and Jewelry.	
Gold	90	Gold	80
Copper	10	Copper	20
Silver Coin.		**Silver Jewelry.**	
Silver	90	Silver	80
Copper	10	Copper	20
Aluminium Bronze.		**Pinchbeck.**	
Copper	90	Copper	90
Aluminium	10	Zinc	10
Brass.		**Bronze Cannon.**	
Copper	70	Copper	90
Zinc	30	Tin	10
German Silver.		**Babbitt Metal.**	
Copper	45	Copper	2
Zinc	30	Antimony	3
Nickel	25	Tin	12
Pewter.		**Plumber's Solder.**	
Tin	92	Tin	67
Lead	8	Lead	33

The affinity of an alloy for oxygen is greater than that of the separate metals, a phenomenon that is ascribed by some to the increase of affinity for oxygen which results from the tendency of one of the oxids to combine with the other; by others it is attributed to galvanic action. Accord-

ing to Faraday, 100 parts of steel alloyed with one of platinum is dissolved with effervescence in dilute sulphuric acid too weak to act with perceptible energy on common steel. It is offered in explanation of this fact that the steel is rendered positive by the presence of platinum.

Fusible Metals.—A series of alloys, usually known as *fusible metals*, consist chiefly of lead, tin, bismuth, and cadmium. The several metals are fused in a crucible under a layer of charcoal and stirred thoroughly before pouring. A very small percentage of mercury is sometimes added just before pouring to further lower the fusing point. By the union of these metals in certain proportions alloys may be obtained which will fuse below the boiling point of water; tin and bismuth, for instance—both having low melting points, form alloys which melt at a considerably lower temperature than either of the metals separately. The formulas of a few of the well known fusible metals are as follows:

Newton's Alloy. Fusing Point 202° F.	Parts.
Bismuth	8
Tin	8
Lead	5

Rose's Alloy. Fusing Point 175° F.	Parts.
Bismuth	8
Tin	3
Lead	8

Wood's Alloy. Fusing Point 160° F.	Parts.
Bismuth	5
Tin	2
Lead	4
Cadmium	2

Lipowitz Alloy. Fusing Point 145° F.	Parts.
Bismuth	15
Tin	4
Lead	8
Cadmium	3

SOLDERS AND SOLDERING.

Solders are fusible alloys used for joining or binding together two or more metallic surfaces or joints. These alloys must necessarily be more fusible than the metals to be united, and should have a strong affinity for them. These alloys are made in the same manner as other alloys, that is,

melted under a layer of charcoal and stirred well before pouring. When a solder melts above red heat it is called a *hard solder*. When it melts below this point it is known as a *soft solder*. It is the former class, those managed with the blowpipe or other flame, which we shall consider here. The soft solders are flown and directed by a hot iron known as a soldering iron.

Soldering, as has been indicated, refers to the union of two or more pieces of metal, by a more fusible metal or alloy. The several conditions necessary for successful soldering are:

(1) Contact of the metals to be united.
(2) Clean surfaces over which the solder is to flow.
(3) A freely flowing solder.
(4) A flux to facilitate the operation.
(5) The proper amount and distribution of heat.

Each of the above conditions, though apparently simple, is of much importance. If they are carefully followed the operation is not a difficult one. The quantity of solder used should always be reduced to the minimum. Outside of the question of economy it is undesirable to have a considerable amount of excess of solder as it is difficult to remove in finishing the piece, and it is also liable to cause fracture of porcelain teeth or otherwise injure the case, from contraction on cooling.

Cleanliness is one of the conditions. This refers to the solder itself, as well as the metals to be soldered. All should be free from oxidation, carbon, plaster of paris or other foreign substances. The removal of slight oxidation is accomplished by the flux used. Borax being generally employed for this purpose, and when melted by the flame dissolves any slight oxidation and protects the metallic surface from further oxidation by protecting it from the atmosphere. The management of the flame also can not be too

carefully considered. It is in this that many fail and hence consider soldering a most difficult operation.

(1) A smoky or *oxidizing flame* should be avoided.

(2) The heat should be applied at first very gradually and uniformly.

(3) After the case is thoroughly heated, direct the flow of the solder with a small, soft, and pencil-like flame, remembering that solder flows to the hottest point. The heating process, whether for bridge and crown work, or for plate work, should be conducted very gradually. In any case the too sudden application of heat may cause displacement of the pieces of solder by the puffing up or swelling of the borax. But where porcelain teeth are involved the too sudden elevation of heat may result in fracture of the teeth or the cracking and displacement of the investment, owing to the too rapid expulsion of moisture.

We repeat, solder flows to the hottest point. If, therefore, we are endeavoring to solder teeth to a plate, and the teeth and surrounding investment have not been thoroughly heated up, the solder, when it melts, will flow back upon the plate. In soldering a wire or other small attachments to a plate or band, the small piece will become heated more quickly and attract the flowing solder to itself. The flame, therefore, should be directed through or upon the larger piece.

Soldering is not a difficult operation. It simply needs to be conducted with care and intelligence.

Fluxes.—Substances coming under this head are used in soldering, to remove oxidation and to assist in the flow of the solder. They are employed in melting metals to combine with the oxids and to protect the molten mass from further oxidation; in smelting ores they form a combination with the infusible substances, forming what is termed a slag. The flux principally employed in the dental labo-

ratory, both for melting metals and soldering, is *borax*. This substance fuses readily and flows freely when in the molten state. The commercial borax contains water of crystallization to about one-half its weight; it is the driving off of this water which causes the puffing up or swelling of the borax in soldering. This may be largely overcome by using fused or dehydrated borax. Other fluxes and refining agents are potassium nitrate (saltpeter), which yields oxygen; murcuric chlorid (corrosive sublimate), or ammonium chlorid (sal-ammonium), both of which yield chlorin; sodium chlorid (common salt), resin, powdered charcoal, etc., are also frequently employed when melting metals to protect them from oxidizing.

INDEX.

ADHESION, 86, 196
Air-chamber, manner of forming, 15
Alloys, general properties, etc., 249
  eutectic, 251
  gold, 202
    method of determining carat, converting into required forms, 205
Aluminum, general properties, etc., 229
  alloys of, 231
Alveolar ridge, lack of symmetry in, 4
Amalgams, 244
  formulæ for, 249
Annealing, 83
Antagonizing models, for partial dentures, 24
  entire dentures, 25
  upper dentures, 22
Antimony, 240
Appliances for correcting irregularities, 133
Application of gum enamel, 113
Arrangement of teeth, 27–43, 94
Articulation of teeth, 39
Artificial dentures, cast metal base, 100
  celluloid base, 62
  "continuous gum" base, 109
  electro-deposit base, 102
  rubber base, 43
  swaged base, 76
Artificial palates, 118
Atmospheric pressure or adhesion, 86
Attaching teeth to a metallic base with rubber or celluloid, 115

Babbitt metal, 253
Backing teeth, 97
  in rubber work, 58
Baker's velum, 126
Baking funaces, 112
Base metals, 199
Beaded or grooved dentures, 59
Beeswax, 8
"Best" celluloid heater, 70
Bismuth, 241
Bite, manner of taking, 20
Bridge-dentures, 184
  -splint, 192

Carving the model, 25
Case's enamel cleaver, 166
Cast metal base, 100
Celluloid base, 62
  carving for, 65
  composition of, 63
  facing to other bases, 74
  finishing process, 73
  flasking for, 66
  formula for, 63
  grooves or gates, 67
  heater, 69
  metal casts for, 64
  molding, 69
  plaster model, 63
  processes preliminary to molding, 76
  selecting blank for, 68
Clasps, 59
  adjusting to plate, 84
  modification in form of, 59
  uniting the plate and, 85
  vulcanite plate attached to, 59
Cohesion, 196
Conductivity of metals, 196
Continuous-gum work, 109
  applying the body, 110
  applying the gum enamel, 113
  attaching the teeth, 110
  final baking, 113
  first baking, 111
  the Sharp furnace, 112
Converting gold alloys into required forms, 202
Copper, general properties, etc., 235
Counter-dies, metallic, 81
Crown, Downie, 177
  ferrule or collar, 165
  gold, 180

Logan, 163
Mason, 178
Richmond, 165
Crown- and bridge-work, 159

Defects in palatine organs, 118
Dentimeter, 167
Dies, metallic, 76
Ductility, 195
Downey crown, 177

Electro-deposit, base, 102
copper, 102
gold, 107
silver, 104
preparation of batteries, 103
Elasticity of metals, 196
Elements employed in refining gold, 215
Enamel cleaver, 166
Entire dentures, 21
antagonizing wax models, 24
esthetic requirements in the selection and arrangement of the teeth for, 27
table of temperaments, 33
Esthetic requirements in selecting and arrangement of teeth, 27
Eutectic alloys, 251
Examination of the mouth, 2

Faulty articulation, 40
Ferrule or collar crown, 165
Flasking for rubber, 44
for celluloid, 66
Flasks for moulding, 79
Fluxes, 256
Formula for Babbitt metal, 253
celluloid, 67
gold plate, 203
gold solders, 205
silver solders, 228
Furnace, Sharp's, 112
Fusibility, 196
Fusible alloys, 254

Gas furnace, Sharp's, 112
Gates or outlet grooves in flasking rubber, 48
General properties of alloys, 249
Gold, properties of, 201
alloys of, 202
elements employed in refining, 215
formulas for plate and solder, 203–205
influences of alloying, 201
making of plate, etc., 208
Miller's process of refining, 218
reduction of, to lower standard of fineness, 206
solders, 204
to raise from a lower to a higher standard, 206
Grinding and articulating teeth, 89, 93

Hardening and tempering steel, 239
Hardness of metals, 196
Hawes molding flask, 79
Heaters, celluloid, 69

Impression cups or trays, 8
Impressions of the mouth, 8
manner of taking, 8–16
materials used for, 5–8
Interdental splints, 127
Investing, 97
Iridium, 225
Iron, general properties, etc., 237
Irregularities, appliances for correcting, 133

Jointing, gum or block teeth, 42

Kingsley's artificial velum, 119
interdental splint, 132

Lead, general properties, etc., 233
use in laboratory, 254
Lower dentures, 91

Malleability, 195
Manner of removing impressions, 12
Materials for impressions, 6
Manner of obtaining plaster casts, 16
Mason crown, 178
Mechanical forces in regulating, 133
Mercury, physical properties, etc., 242
Metal casts for moulding celluloid, 64
Metallic base plate, rubber attachment, 115
methods of making attachments, 115
clasps attached to rubber plates, 59

dies and counter-dies, 76
Metallurgy, 195
Metals, physical properties of, 195
noble and base, 199
Method of taking impressions, 20
Miller's process of refining gold, 218
Modeling composition, 6
Models, plaster, 16
Moldine, 8
Molding, materials for, 76
preparation of cast for, 77
Molecular structure of metals, 195

Noble metals, 199

Obturators, Baker's, 126
Kingsley's, 119
Suerson's, 123
Ottolengui root-facers, 160
root reamers, 162
Outlet grooves or gates, 48

Packing rubber, 49
Palatal organs, defects of, 118
Partial dentures, 84
antagonizing models for, 24
Pattern, forming, for plate, 80
Physical properties of metals, 195
Pink rubber gum, 56
Plaster casts, 16
from an impression in wax or modeling compound, 14
from an impression in plaster, 17–20
Plaster-of-Paris, 5
derivation, 5
method of hastening setting, 6
method of mixing, 9
preparation of, 5
Platinum, general properties, etc., 223
Preparation of root for crowning, 159
Pressure anesthesia, 161
Purple-of-Cassius, 222

Reduction of gold to a lower standard of fineness, 206
of gold solders to proper forms for use, 204
Refining gold, 215
silver, 226
Regulating teeth, 133
Reposing the features, 27
Retaining devices for regulating teeth, 155
Retching, treatment of, 11
Rimming plate, 96
Root crowning, 159
Rubber as a dental base, 43
composition of, 44
finishing, 56
pink, as a gum, 56

Selecting artificial teeth, 35
Separating fluids, 20
Separation of cast from impression, 17
of foreign metals from gold, 230
Shade of the teeth, 35
Shaping the cutting edges of teeth, 40
Silver, general properties of, 225
refining, 226
solders, 228
Solder, gold, 204
silver, 228
Soldered "air chamber," 89
Soldering, 98
Solders and soldering, 254
Splints, interdental, 127
Steel, 239
Suerson's obturator, 123
Swaging plates, 76, 81, 91

Table of temperaments, 33, 34
Taking the bite, 20
Temperamental indications in arranging of teeth, 31
Tempering, 239
Tenacity, 196
Tests for perfect impression, 11
The teeth as indicated by temperament, 31
The soldering process, 98
Tin, general properties, etc., 234
dental uses, 235
Toughness of metals, 196
Touchstone for testing gold, 221

Treatment for retching, 11
Vacuum chamber, 87
Varnish, formulæ for, 20
holder, the clover leaf, 21
Vulcanized base plate, 43
finishing, 56
flasking for, 44

outlet grooves or gates, 48
packing, 49
pink rubber facing, 56
repair, 60
vulcanizing, 51

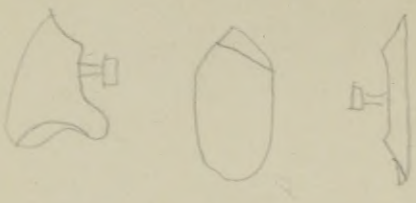
Vulcanizers, 53

Wax, yellow, 8
white, 8
Weirich's enamel cleaver, 167
Welding, 198

Zinc, general properties, 232
use for dental purposes, 232

The teeth forming the bridge between crowns are called dummies

Occlusal surface — a trifle narrower from labial to palatal side than natural teeth



5 lead + 1 tin for common dirt
do not use wire for silverplate, because
change margin.